II. Planning For and Identifying Community Hazards

HAZARDOUS WEATHER FACT SHEETS

INTRODUCTION

This section contains fact sheets on the most common hazardous weather events that occur in the United States. Each fact sheet includes:

- A definition of the event.
- Characteristics common to the event, including hazards and dangers.
- Historical examples of the types and amounts of damage that each event may cause.

As you review the potential hazards, consider:

- Which hazards are most likely to occur in your community?
- What types of damage are the hazards likely to cause?
- Which area(s) of your community are likely to be hardest hit?
- How does your community's Emergency Operations Plan (EOP) address the response needs created by these hazards?
- If an incident occurred, what assistance would your community require from:
  - Mutual aid partners?
  - The State?
  - FEMA?

Answering these questions will help you to be prepared better for your community's emergency planning process.

Refer to this section during your planning process or when you want to know about a specific event and the danger that it potentially poses to your community.

THUNDERSTORMS

DEFINITION

A thunderstorm is a local storm produced by a cumulonimbus cloud and is always accompanied by lightning and thunder. Thunderstorms also are accompanied often by gusty winds, heavy rain, and occasionally by hail. Thunderstorms sometimes may be violent at the surface. Thunderstorms may be classified as ordinary, approaching severe (or non-severe), or severe. Thunderstorm categories, as classified by wind speed and precipitation, are shown in the table below.

CATEGORY	*WIND SPEED*	*PRECIPITATION*
Ordinary	< 35 knots (40 m.p.h.)	Variable
Approaching Severe	≥ 35 knots (40 m.p.h.)	Hail > ½ inch
Severe	≥ 50 knots (58 m.p.h.)	Hail ≥ 3/4 inch

CHARACTERISTICS

The characteristics of thunderstorms depend on the type of storm that develops. To understand the differences in the types of storms, a brief discussion on the ingredients and stages is necessary.

Three basic factors contribute to thunderstorm development: moisture, instability, and lift.

- **Moisture** comes from large bodies of water (e.g., oceans, bays, the Great Lakes) or possibly from large vegetation areas.
- **Instability** is related to the rate at which temperature decreases with height and moisture content of the air. The NWS uses Lift Index (LI) and Convective Available Potential Energy (CAPE) to measure instability. The more unstable the air mass, the more severe the thunderstorm.
- **Lift** can be caused by fronts, sea breezes, heat rising from the Earth's surface, outflow boundaries from prior thunderstorms, or dry line boundaries. Lift brings warm air up through the air mass.

CHARACTERISTICS

These factors combine to develop into thunderstorms in three stages.

- **Developing Stage:** A towering cumulus cloud forms as air rises. The cloud extends to about 20,000 feet above the level of freezing temperatures. Usually there is little if any rain, but occasional lightning occurs during this stage, which lasts about 10 minutes.
- **Mature Stage:** During this stage, the storm builds to heights of 40,000 feet or more. This is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance. The mature stage lasts an average of between 10 and 20 minutes, but may last much longer.
- **Dissipating Stage:** Downdrafts begin to choke off the supply of air that feeds the storm, the storm stops building, loses height, and dissipates. Rainfall decreases in intensity, but some thunderstorms produce a burst of strong winds in this stage, and lightning remains a danger.

Thunderstorms are categorized into four types.

- **Single Cell:** Single-cell thunderstorms are short lived (i.e., generally lasting 20-30 minutes or less) and are stifled by intensifying downdrafts. These storms are relatively uncommon and cover a limited area (i.e., only a few square miles).
- **Multicell:** Multicell storms are most common. A multicell storm is an organized cluster of two or more single-cell storms. Air flowing out of one storm fuels other storms, causing new cells to develop on the right or right-rear storm flank every 5 to 15 minutes.
- **Squall lines:** A line or narrow band of active thunderstorms, a squall line may extend over 250 to 500 miles, may be from 10 to 20 miles wide, and consist of many laterally aligned cells that do not interfere with one another. The cells may be ordinary, non-severe, or severe, and they may be multicell, supercell, or a combination of these. Squall-line storms may form along cold fronts but often form as much as 100 miles ahead of an advancing cold front in the warm sector of an extratropical storm. They often trail a large, flat cloud layer that brings significant rain after the storms pass.
- **Supercell:** Supercells are relatively uncommon but produce the most severe and longest lasting (1 to 6 hours) weather. Supercells can travel 200 miles or more. These storms can cause strong winds of more than 78 m.p.h, giant hail (e.g., 2 inches), and significant tornado activity. Supercells produce updrafts of between 56 and 112 m.p.h. that coexist with sustained downdrafts. Together, the updrafts and downdrafts act to extend the storm's duration.

CHARACTERISTICS

The NWS uses the Lift Index (LI) and Convective Available Potential Energy (CAPE) to indicate atmospheric instability, which is a measure of the potential severity of a thunderstorm.

- ✦ The greater the instability, the more severe the thunderstorm.
- ✦ LIs with greater negative numbers indicate a greater degree of instability.
- ✦ CAPE is a positive number—the higher the number, the greater the instability.

Thunderstorms most often occur in the spring and summer, during the afternoon and evenings, but can occur at any time.

Hazards associated with thunderstorms include:

- ✦ Lightning.
- ✦ Hail.
- ✦ Damaging winds.
- ✦ Heavy rain causing flash flooding.
- ✦ Tornadoes.
- ✦ Fires caused by lightning produced by dry thunderstorms.

The damaging winds of thunderstorms include straight-line winds, downbursts, and micro bursts.

- ✦ Straight-line winds are high winds across a wide area.
- ✦ Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground.
- ✦ Micro bursts are minimized downbursts covering an area of less than 2.5 miles across. They induce a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Micro bursts may or may not include precipitation and can produce winds over 150 m.p.h.

HISTORICAL EXAMPLES

- ✦ In May 1995, a hailstorm in Dallas, Texas dropped softball-sized hail, damaging more than 100 planes at the Dallas-Fort Worth Airport and causing $750 million in damage, 510 injuries, and 21 deaths.
- ✦ In April 1974, treacherous thunderstorms developed in the Midwest. Cold, dry air pushed east by a low-pressure center east of the Rockies; an extratropical storm bringing warm, humid air north from the Gulf; the jet stream winds bringing dry air from Texas; and cool, humid air in the Northeast set up the storms. The storms caused 127 tornadoes, the largest, most damaging tornado outbreak in U.S. history. More than 300 people were killed, 6,142 were injured, and damage was estimated at $600 million.

PRODUCTS

The table below and on the next pages lists NWS products that can provide planning and preparedness information on thunderstorms. Refer to the fact sheets on coastal floods, extratropical coastal cyclones, tornadoes, and riverine floods for other products.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks			
Convective Outlook Day 2	MKCSWODY2	Storm Prediction Center (SPC)	Forecast for severe thunderstorms for the contiguous 48 States for the next day (DY2) and that day (DY1). Includes areas, degree of risk or probability, hazards, and severity.
Convective Outlook Day 1	MKCSWODY1	SPC	
Public Weather Outlook	MKCPWOMKC	SPC	Discussion of an especially significant and/or widespread outbreak of severe thunderstorms.
Severe Weather Outlook	___SPS___	Local NWS Office	This is a local outlook for the potential of severe weather. It includes hazards, locations, severity, and timeframes.
Watches			
Severe Thunderstorm Watch	MKCSEL (1-9)*	SPC	A watch contains: ✦ Type of severe weather. ✦ Watch area. ✦ Valid period. ✦ Type of severe weather possible. ✦ Intensity of severe weather. ✦ Watch axis. ✦ Meaning of the watch. ✦ Call-to-action statements. ✦ Discussion of meteorological reasoning. ✦ Other watch information.
Watch Cancellation	MCKSEL (1-9)*		This product cancels a severe thunderstorm watch.

*1-9 indicates the consecutive number of the issuance for the day.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Statements			
Severe Thunderstorm Watch Redefining Statement	___SLS___	Local NWS Office	Provides geographical or areal redefinition of a specific watch area including States, counties, and cities at risk.
Special Weather Statement	___SPS___	Local NWS Office	Provides for clearance of counties from local severe thunderstorm watches.
Severe Weather Statement	___SVS___	Local NWS Office	Provides: ✦ A brief report of imminent danger. ✦ A cancellation of all or part of a warning. ✦ An extended watch for 1–2 hours.
Advisories/Warnings			
Severe Thunderstorm Warning	___SVR___	Local NWS Office	Warning for severe thunderstorm(s) includes the: ✦ Hazards. ✦ Affected area. ✦ Expiration time. ✦ Basis of warning. ✦ Threat to confirmation. ✦ Location and movement. ✦ Call-to-action statements. NOTE: Warnings for severe thunderstorms, flash floods, and tornadoes may be combined and issued under one header based on the most severe threat.
Special Marine Warnings	___SMW___	Local NWS Office	Issued for severe thunderstorms over large bodies of water and include the same types of information as do severe thunderstorm warnings.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Discussions SPS Mesoscale Discussion	MKCSWOMCD	SPC	This is a daily unscheduled product used to communicate the current judgment of SPC forecasters to the user community.
Short Term Forecasts	___NOW___	Local NWS Offices	The NOW is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

TORNADOES

DEFINITION

Tornadoes are the most violent storms on Earth, with estimated wind speeds of 250 m.p.h. or more. A tornado is a violently rotating column of air that extends from the base of a thunderstorm and comes in contact with the ground. The spinning motion of a tornado is almost always counterclockwise.

Thunderstorms develop in warm, moist air in advance of eastward-moving cold fronts. These thunderstorms often produce large hail, strong winds, and tornadoes. Tornadoes in the winter and early spring are often associated with strong, frontal systems that form in the Central States and move east. Occasionally, large outbreaks of tornadoes occur with this type of weather pattern. Several States may be affected by numerous severe thunderstorms and tornadoes.

During the spring in the Central Plains, thunderstorms frequently develop along a "dryline," which separates very warm, moist air to the east from hot, dry air to the west. Tornado-producing thunderstorms may form as the dryline moves east during the afternoon hours.

Along the front range of the Rocky Mountains, in the Texas panhandle, and in the southern High Plains, thunderstorms frequently form as air near the ground flows "upslope" toward higher terrain. If other favorable conditions exist, these thunderstorms can produce tornadoes.

Tornadoes occasionally accompany tropical storms and hurricanes that move over land. Tornadoes are most common to the right and ahead of the path of the storm center as it comes onshore.

A **funnel cloud** is a similar column of air that is not in contact with the ground. A **water spout** is a tornado that is over water. When either a funnel cloud or a water spout come in contact with the ground, they become, by definition, a tornado.

The visible column is composed of water droplets formed by condensation in the funnel. The fast-moving winds (either flowing into the tornado or in the main tornadic circulation) cause most of the damage. The vortex (or multiple vortexes) sucks in air from near the ground, along with dirt and debris. The dirt and debris block light, giving the tornado a dark color.

Tornadoes are defined in terms of the Fujita Scale, which ranks tornadoes on the basis of wind speed and damage potential. The Fujita Scale is shown in the following table.

DEFINITION

CATEGORY	*WIND SPEED*	*EFFECTS*
F0	40-72 m.p.h.	**Light damage:** Some damage to chimneys; branches break from trees; shallow rooted trees pushed over; sign boards damaged.
F1	73-112 m.p.h.	**Moderate damage:** Roof surfaces peeled off; mobile homes pushed from foundations or overturned; cars pushed off roads.
F2	113-157 m.p.h.	**Considerable damage:** Roofs torn off frame houses; mobile homes demolished; large trees snapped or uprooted.
F3	158-206 m.p.h.	**Severe damage:** Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	207-260 m.p.h.	**Devastating damage:** Well-constructed houses leveled; structures with weak foundations blown off some distance.
F5	261-318 m.p.h.	**Incredible damage:** Strong frame houses lifted off foundations and carried considerable distance to disintegrate.

- F0 and F1 tornadoes comprise 70 percent of all tornadoes that occur in the U.S. They usually touch down briefly and cause minor damage. However, forecasting these tornadoes is less reliable than for stronger tornadoes, so less than 50 percent occur during tornado watches.
- F2 and F3 tornadoes comprise about 28 percent of the tornadoes in the U.S. They can cause significant damage and cause injuries and deaths.
- F4 and F5 tornadoes comprise about two percent of the tornadoes in the U.S. and cause 70 percent of the death and destruction. Fortunately, the NWS has identified precursor conditions for the more damaging tornadoes. Over 95 percent of these tornadoes, therefore, occur during tornado watches.

CHARACTERISTICS

- **Wind.** Tornadoes consist of strong, often destructive winds. The winds in the strongest tornadoes are the fastest winds experienced anywhere on Earth, with rotation velocities up to 300 m.p.h.
- **Rain/hail.** Tornadoes are associated with thunderstorms, so they may be preceded or followed by heavy rainfall or hail. Depending on the hydrological conditions, flash flooding may occur.
- **Total destruction of homes,** especially mobile homes, businesses, and cars, causing many deaths.
- **Extensive tree damage** along roadways, which may inhibit or block access.
- **Extensive damage** to electric and telephone lines.
- **Utility line breaks.**
- **Damaged or destroyed radio and television towers.**

CHARACTERISTICS

Tornadoes develop as an outgrowth of thunderstorms. Large, strong, and long-lasting tornadoes are spawned by supercells. Once a thunderstorm has formed, given the right ingredients, a tornado can develop.

- A thunderstorm needs rising air for a tornado to form.
- The rising air begins to rotate because of strongly changing (veering) winds in the lower part of the atmosphere.

Each year, approximately 800 tornadoes touch down in the United States—the highest frequency in the world. Tornadoes occur most often when the lower layer of air is warm, which varies according to the time of year:

- Midwestern U.S.: April, May, and June.
- Southwest and North Central U.S.: May, June, July, August, and September.
- Southeastern U.S.: March, April, May, and June.
- Western U.S.: April, May, June, July, and August.

HISTORICAL EXAMPLES

- An outbreak of tornadoes hit the Midwest on April 26-27, 1991. Fifty-four tornadoes caused 21 deaths, 308 injuries, and over $277 million in damages. Fifteen deaths occurred in or near mobile homes, and two occurred in vehicles.
- An outbreak of 41 tornadoes hit the area of Lake Erie and Lake Ontario on May 31, 1985, causing 75 deaths in the U.S. There were 1,025 injuries, and these tornadoes caused $450 million in damages.
- On March 28, 1984, 22 tornadoes hit North and South Carolina in the afternoon and evening. They caused 57 deaths, over 1,000 injuries, and $200 million in damages. Thirty-seven percent of the fatalities were in mobile homes.
- In April 1974, treacherous thunderstorms developed in the Midwest, causing 127 tornadoes, the largest, most damaging tornado outbreak in U.S. history. Over 300 people were killed, 6,142 were injured, and damages were estimated at $600 million.

PRODUCTS

The table below and on the next pages lists products that can provide planning and preparedness information on tornadoes. Refer to the fact sheet on thunderstorms for more products.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks			
Convective Outlook Day 2	MKCSWODY2	Storm Prediction Center (SPC)	Forecast for severe thunderstorms, including tornadoes, for the contiguous 48 States for the next day (DY2) and that day (DY1). Includes areas, degree of risk or probability, hazards, and severity.
Convective Outlook Day 1	MKCSWODY1	SPC	
Public Weather Outlook	MKCPWOMKC	SPC	Discussion of an especially significant and/or widespread outbreak of severe thunderstorms.
Severe Weather Outlook	___SPS___	Local NWS Office	This is a local outlook for the potential of severe weather. It includes hazards, locations, severity, and timeframes.
Watches			
Tornado Watch	MKCSEL (1-9)*	SPC	A watch contains: ✦ Type of severe weather watch. ✦ Watch area. ✦ Valid period. ✦ Type of severe weather possible. ✦ Intensity of severe weather. ✦ Watch axis. ✦ Meaning of watch. ✦ Call-to-action statement. ✦ Discussion of meteorological reasoning. ✦ Other watch information.
Watch Cancellation	MKCSEL (1-9)*	SPC	This product cancels a tornado watch.

*1-9 indicates the consecutive number of issuance for the day.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Statements			
Tornado Watch Redefining Statement	___SLS___	Local NWS Office	Provides geographical or areal redefinition of a specific severe thunderstorm watch area including States, counties, and cities at risk.
Special Weather Statement	___SPS___	Local NWS Office	Provides for clearance of counties from local severe thunderstorm watches.
Severe Weather Statement	___SVS___	Local NWS Office	Provides: ✦ A brief report of imminent danger. ✦ A cancellation of all or part of a warning. ✦ An extended watch for 1–2 hours.
Warnings/ Advisories			
Tornado Warning	___TOR___	Local NWS Office	A tornado warning includes: ✦ Hazards. ✦ An affected area. ✦ Expiration time. ✦ A basis of warning. ✦ A threat confirmation. ✦ The location and movement. ✦ A call-to-action statement. NOTE: Warnings for tornadoes, severe thunderstorms, and flash floods may be combined and issued under one header based on the most severe threat.
Special Marine Warnings	___SMW___	Local NWS Office	Issued for water spouts and include the same types of information as do tornado warnings.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Discussions SPS Mesoscale Discussion	MKCSWOMCD	SPC	This is a daily, unscheduled product used to communicate the current judgment of SPC forecasters about the potential of severe weather to the user community.
Short Term Forecasts	___NOW___	Local NWS Offices	This is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

FLASH FLOODS

DEFINITION

A flash flood occurs suddenly, within a short time (from minutes to less than 6 hours) after a causative event. Flash floods are the number one weather-related killer in the United States. Nearly half of all flash-flood fatalities are auto related.

Causative events include heavy rains from slow-moving thunderstorms, dam or levee failure, or the sudden release of water from the breakup of an ice jam. Intense short-duration rainfall on impervious areas, such as roads or nonabsorbing certain soils, also causes flash floods.

Flash floods are most prevalent on small streams, generally draining areas ranging in size from a few square miles to several hundred square miles. The most dangerous flash floods are usually associated with steep mountain streams, canyons, and desert washes where they can manifest themselves as a wall of water traveling downstream.

CHARACTERISTICS

Rainfall intensity and duration affect the potential for flash floods. Other non-meteorological factors that could affect an area's ability to absorb water include the topography, soil conditions, and ground cover.

Topography is important, especially where there are steep slopes. Gravity rapidly moves the water to the lowest point(s), reducing the time the runoff is susceptible to being absorbed by the ground, as well as funneling water from larger areas into the lowest region.

Some soils can absorb runoff more effectively (i.e., sand is better than clay) and reduce runoff. Soils covered with vegetation tend to retard runoff and mitigate rapid accumulation of water at low points. Wet soils have limited capability to absorb runoff, so rainfall is more effective in causing flooding when soils are moist. Frozen soils also do not allow for absorption of runoff. Finally, some soils, such as clay, that have been "baked" by long periods of hot, dry conditions, often have little capability to absorb runoff.

The most severe flash floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels. However, less serious flash flooding is still capable of taking lives. As little as a foot of moving water is enough to sweep a car into deeper flood waters. Also, children playing in flood waters, especially near culverts and drainage pipes, can be swept away. Other hazards associated with flash floods include:

- **Sudden release of huge walls of water**. Floating debris or ice can collect at an obstruction and restrict the flow of water. Pressure builds up behind the jam, and when the pressure bursts through, a huge wall of water of up to 30 feet is released, causing tremendous destruction.
- **Debris flows**. Debris caught in the water flow acts as battering rams, causing additional destruction.
- **Mud slides**. Flash floods can also trigger mud slides in areas with clay soils, saturated soils, or little ground cover.

HISTORICAL EXAMPLES

- In May 1889, a dam break in Johnstown, Pennsylvania, caused the worst flood in U.S. history. A 36- to 40-foot wall of water left over 2,200 dead.
- In June 1990, four inches of rain fell in less than 2 hours at Shadyside, Ohio, producing a 30-foot high wall of water. It caused 26 deaths and $6 to $8 million in damages.
- In Cheyenne, Wyoming, six inches of rain fell in 3 hours in August 1985. The flood left 12 dead and caused $61 million in damages.
- In July 1976, the headwaters of Big Thompson Canyon in Colorado received 10 to 12 inches of rain, most of it in 2 hours. The rain produced a 19-foot wall of water and debris, which caused about $35.5 million in damages. Victims had little warning, and 139 people were killed.
- In July 1972, Rapid City, South Dakota had 15 inches of rain in a 5-hour time period. The resulting flood caused 238 deaths and $164 million in damages.

PRODUCTS

The table on the following pages lists NWS products that can provide planning and preparedness information on flash floods. Refer to the fact sheet on riverine floods for other products.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Flood Potential Outlook	___ESF___	Local NWS Office	This product is issued when conditions indicate that significantly heavy precipitation will cause or aggravate flash flooding. It is issued with a 36-hour or greater lead time. It includes the: ✦ Area affected. ✦ Timeframes. ✦ Discussion of hydrologic and meteorological factors and conditions. ✦ Information on projected watches and warnings.
Watches Flash Flood Watch	___FFA___	Local NWS Office	A Flash Flood Watch is used to inform cooperating agencies and the public about the threat of flash flooding. It covers precipitation, snow/ice melt, and dam break conditions. It includes the: ✦ Area affected. ✦ Timeframes. ✦ Conditions. ✦ Extent of hazardous conditions possible. ✦ Potential severity. ✦ Call-to-action statements.
Statements Flash Flood Statement	___FFS___	Local NWS Office	This product is issued to provide updates to flash flood watches and warnings. It can provide the: ✦ Latest information on flooding. ✦ Reduction in the area covered by a watch or warning. ✦ Termination of a watch or warning.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings			
Urban and Small Stream Flood Advisory	___FFS___	Local NWS Office	This product is designed to provide advance notice for flash flooding on small streams and in urban areas such as roads, underpasses and low-lying areas. This product is used for situations that are primarily a major inconvenience, *not* a life-threatening flood. It includes the: ✦ Area affected. ✦ Timeframes. ✦ Location and movement of flood producing storms. ✦ Call-to-action statement.
Flash Flood Warning	___FFW___	Local NWS Office	This warning indicates flash flooding is imminent or in progress. The warning should include the: ✦ Timeframes. ✦ Areas impacted. ✦ Severity of the flood. ✦ Movement of the flood. ✦ Call-to-action statement. ✦ Time of next issuance.
Discussions			
Hydrometeorological Discussion	__HMD__	River Forecast Centers (RFCs)	This product summarizes the current hydrometeorological situation, general trends of the RFC's hydrologic forecasts, and flood potential for the entire RFC area. The types of conditions monitored include: ✦ Areas where data indicate significant potential for runoff-causing rainfall. ✦ Rivers that are already above flood stage. ✦ Areas where soil moisture is above normal due to recent excessive rainfall. ✦ Areas covered by a significant, ripe snowpack that could readily melt in changing meteorological conditions such as a rain-on-snow event or a heat wave.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Discussions (Continued) Hydrometeorological Discussion (Continued)	__HMD__	River Forecast Centers (RFCs)	✦ Areas where frozen ground could generate dangerous runoff with moderate rainfall. ✦ Areas where ice jam breakups could potentially produce backwater flooding or dam-break-like flood conditions.
Short Term Forecasts N/A			

RIVERINE FLOODS

DEFINITION

Whereas flash floods occur quickly after an upstream event, riverine flooding is a longer term event that may last a week or more.

Flooding along rivers and streams is natural and inevitable. Some floods occur seasonally when winter or spring rains, coupled with melting snows, fill river basins with too much water too quickly. Torrential rains from hurricanes or tropical systems also can produce river and stream flooding.

Riverine flooding occurs when a stream flows over its banks and causes considerable inundation of nearby land and roads. On a leveed stream, these flows may be contained within the levees. However, uncontrolled flooding would occur if the stream level rises above the levee or if the levee fails. The ability of the levee to withstand flooding depends on the design standards used when constructing the levee, as well as on operation, planning and maintenance. Many private (mostly agricultural) levees are not built to withstand major floods.

CHARACTERISTICS

Riverine flooding is normally the result of a combination of meteorological and hydrological factors. Although excessive rainfall alone can cause flooding, the most severe riverine floods usually have multiple causative factors. These factors may include:

- ✦ Heavy, prolonged rainfall from large-scale storms or a series of large-scale storms.
- ✦ Heavy rainfall from a near-stationary or slow-moving thunderstorm complex.
- ✦ Saturated soil conditions from previous rainfall events.
- ✦ High existing river flows from previous rainfall events.
- ✦ Extreme cold temperatures followed by thawing, leading to river ice jams.

The dangers of riverine floods are similar to coastal and flash floods. Dangers include:

- ✦ Damaged or destroyed buildings and vehicles.
- ✦ Uprooted trees causing power and utility outages.
- ✦ Drowning, especially people trapped in cars.
- ✦ Contamination of drinking water.
- ✦ Dispersion of hazardous materials.
- ✦ Interruption of communications and/or transportation systems.
- ✦ Rapid snowmelt. Snowmelt floods can develop over periods ranging from several hours to several days, depending upon the part of the country, the water content of the snow, and temperatures during the melting period. The combination of large-scale storm rainfall and rapidly melting snow can cause severe flooding.
- ✦ Silt buildup in river channels during previous storm events that reduces the capacity of the river to carry water.

HISTORICAL EXAMPLES

- The Great Flood of 1993 in the Mississippi Valley affected nine States, resulted in 31 deaths, and caused $15 to 20 billion in damage. Months of above-average rainfall, heavy spring rains, saturated soils, continued summer rains, failed levees, and riverbed erosion contributed to the major flooding on the Missouri and Mississippi Rivers and numerous tributaries. Numerous drinking water systems were contaminated; river shipping was closed for 2 months; and crops, homes, businesses, roads, and bridges were destroyed.
- The South-Central Texas River Flood in December 1991 and January 1992 caused widespread flooding in the Guadalupe, Brazos, Trinity, and Colorado River basins. Seventeen inches of rain fell, causing 15 deaths and $100 million in damage.
- In 1979, Tropical Storm Claudette brought 45 inches of rain to an area near Alvin, Texas, contributing to more than $600 million in damage.
- In 1972, Hurricane Agnes fused with another storm system, producing floods in the Northeast that contributed to 122 deaths and $6.4 billion in damage.
- In 1955, long after the winds of Hurricane Diane subsided, the storm brought floods to Pennsylvania, New York, and New England that contributed to nearly 200 deaths and $4.2 billion in damage.

PRODUCTS

The following table lists NWS products that can provide planning and preparedness information on riverine floods.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks			
Flood Potential Outlook	___ESF___	Local NWS Office	This product is issued when conditions indicate that significantly heavy precipitation will cause or aggravate flooding. It is issued with a 36-hour or greater lead time. It includes the: ✦ Area affected. ✦ Timeframes. ✦ Discussion of hydrologic and meteorological factors and conditions. ✦ Information on projected watches and warnings.
Excessive Rain Outlook	NMCGPH94E	NCEP	
Watches			
Flood Watch	___FFA___	Local NWS Office	This is used to inform cooperating agencies and the public about the threat of flooding. It covers precipitation, snow/ice melt, and dam break conditions. It includes the: ✦ Area affected. ✦ Timeframes. ✦ Conditions. ✦ Extent of hazardous conditions possible. ✦ Potential severity. ✦ Call-to-action statement.
Statements			
Flood Statement	___FFS___	Local NWS Office	This product is issued to provide updates to flood watches and warnings. It can provide the: ✦ Latest information on flooding. ✦ Reduction in the area covered by a watch or warning. ✦ Termination of a watch or warning.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
STATEMENTS (Continued)			
Flood Statement	___FLS___	Local NWS Office	This product is issued to update and expand the information in a Flood Warning (FLW, see below). The Flood Statement may be used in lieu of a warning if flooding is forecast, imminent, or existing and presents no threat to life or property. The statement is used also to terminate a Flood Warning.
River Statement	___RVS___	Local NWS Office	This product provides daily river stage forecasts and information about ice jams and ice movement that does not warrant a Flood Warning or a Flood Statement. It is used also to communicate conditions such as low flows, chemical spills, etc.
River Ice Statement	___RVI___	Local NWS Office	This product can contain numeric and/or narrative information on river ice conditions.
Advisories/ Warnings			
Flood Warning	___FLW___	Local NWS Office	This product normally specifies crest information and is issued for specific communities or areas along rivers where flooding has been forecast, is imminent, or is in progress.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Discussions Hydrometeorological Discussion	___HMD___	River Forecast Centers (RFCs)	This product summarizes the current hydrometeorological situation, general trends of the RFC's hydrologic forecasts, and flood potential for the entire RFC area. The types of conditions monitored include: ✦ Areas where QPFs indicate significant potential for runoff-causing rainfall. ✦ Rivers that are already above flood stage. ✦ Areas where soil moisture is above normal due to recent excessive rainfall. ✦ Areas covered by a significant, ripe snowpack that could readily melt in changing meteorological conditions such as a rain-on-snow event or a heat wave. ✦ Areas where frozen ground could generate dangerous runoff with moderate rainfall. ✦ Areas where ice jam breakups could potentially produce backwater flooding or dam-break-like flood conditions.
Short Term Forecasts N/A			

COASTAL FLOODS

DEFINITION

Coastal flooding is the inundation of land areas along the oceanic coast that is caused by sea waters over and above normal tidal action. Such flooding can originate from the ocean front, back bays, sound, etc. Coastal flooding affects the general public and maritime interests along much of the U.S. coastline extending from the shoreline beaches to inland tidal waterways and the tidal portions of river mouths.

Coastal flooding basically results from one or a combination of the following:

- A storm surge and/or seiche reaching land.
- Heavy surf.
- Tidal piling.

Other factors affecting the local severity, extent, and duration of coastal flooding include:

- Tidal cycles.
- Persistence and behavior of the storm that is generating the flooding.
- Topography, shoreline orientation, and bathymetry of the area.
- River stage or stream run-off.
- Presence or absence of offshore reefs or other barriers.
- High winds that exacerbate damage from the water.

Lakeshore flooding affects the general public as well as marine interests in some areas of the Great Lakes. These areas extend from beaches to portions of rivers flowing into the lakes to larger lake plains. The causes of flooding are variable, and the extent of the flooding will be highly dependent on surrounding shore terrain. The underlying causes of lakeshore flooding are:

- **Seiches** in the Great Lakes can be generated either by strong winds blowing along the axis of a lake or by a pressure jump and down draft winds associated with fast moving squall lines over a lake. In either case, water is piled up at one end of the lake. When the forcing mechanism ends, the water sloshes from one end of the lake to the other, causing water fluctuations of perhaps several feet before damping out.
- **Storm surges** on the Great Lakes are characterized by a rise above normal water level along a shore because of the action of wind stress and atmospheric pressure reduction over the open water. Locally generated waves accentuate the storm surge as they are superimposed on the water level as it rises. Surge height is the difference between the observed water level and the level that would have occurred in the absence of the storm (often called the **still water level**).

A **storm surge** is a dome or bulge of water that is caused by wind and pressure forces. It is a rise above the normal water level along a shore that is caused by strong onshore winds and/or reduced atmospheric pressure. The surge height is the difference of the observed water level minus the predicted tide.

A **seiche** is caused by winds that push lake water to one end of the lake. When the storm ends or moves on, the water sloshes to the other end of the lake, causing water level changes of up to several feet.

DEFINITION

The **surf** is the waves in the area between the shoreline and the outermost limit of breakers.

The **Tidal Cycle** is the periodic change in the intensity of tides that is caused primarily by the varying relations among the earth, moon, and sun.

Mean Sea Level (MSL) is the average height of the surface of the sea at a particular location for all stages of the tide over a 19-year period.

The **Datum Plane (tidal datum)** is the horizontal plane, unique to each individual tidal station, to which soundings, ground elevations, or water surface elevations for that station are referred. The plane is called a **tidal datum** when it is defined by a certain phase of the tide.

CHARACTERISTICS

A storm surge is caused by powerful coastal storms that move toward or adjacent to the coastline. It may be worsened by higher than normal astronomical tide levels. Two factors are key in the development of a storm surge:

- **Low barometric pressure** reduces the weight of the air on the ocean surface causing a slight rising (1 to 2 feet) of the surface of the water. This rising creates a dome and a new balance of forces.
- **Wind** sweeps around the dome of water and induces currents that spiral toward the center of the storm. The force of the winds induces high waves that travel away from the storm. Wind is the dominant force at landfall, often bringing violent wave action far inland. The battering of these waves causes damage beyond mere flooding.

The weight of the water piling up creates pressure on water at lower depths. In deep water, the water under pressure can escape rather easily, reducing the height of the dome. Closer to the coasts, however, there is less opportunity for water at lower depths to escape, and the water is forced to rise, elevating the height of the dome. As a result, islands and coastal areas with a short continental shelf that drops off quickly (e.g., Ft. Lauderdale, Florida) have fewer problems with storm surges than areas along the coast that have a wide continental shelf, bays, and "angle" topography (e.g., Florida's Panhandle or the Texas coast).

As storm surge comes ashore, it may combine with the tide. Thus, a 10-foot storm surge, combined with a 2-foot high tide produces a water level or storm tide that is 12 feet tidal datam. The surge does not usually arrive as a wall of water but rather as a rapid rise in the tide to abnormally high levels.

Storm surge, together with heavy rains from the storm that produced the surge, will cause extensive coastal and inland flooding. Other hazards associated with coastal floods include:

- High winds.
- Quickly rising water levels.
- Fierce wave action.
- Shore erosion and seawall destruction.
- Debris from destroyed property carried by the water.

HISTORICAL EXAMPLES

- A nor'easter backed up water and caused coastal flooding on the north side of St. Augustine, FL, when more than five and one-half inches of rain fell during 24 hours on June 5, 1995. This storm caused more than $300,000 worth of damage, and with numerous roads and streets closed, 15 of 23 schools canceled classes.
- In March 1963, a storm surge developed south of a deepening low, causing damage totaling $3 million in Barrow, AK. Buildings and vehicles were damaged, the fresh water supply was contaminated with sea water, and the electrical generating plant received major damage.
- On December 10, 1993, a strong storm hit the Pacific Northwest, causing the spit of beach south of the Grays Harbor Entrance to be breached by the waves. The channel that developed between the ocean and Half Moon Bay kept getting wider and deeper and subjected the city of Westport to frequent wave action, thus eroding the sand dunes protecting the city's wastewater treatment plant. Millions of cubic yards of sand had to be pumped in to fill the breach.

PRODUCTS

The table list below and on the next pages lists NWS products that provide planning and preparedness information on coastal flooding and lakeshore flooding. Refer to thunderstorms, tropical cyclones, and tsunamis fact sheets for other products.

COASTAL FLOODING

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks N/A			
Watches Coastal Flood Watch	___CFA___	Local Weather Service Office	This watch is used to inform the public that coastal flooding is possible approximately 12 to 36 hours after issuance time. Watches include the: ✦ Time of next update. ✦ Geographical area covered. ✦ Valid time of watch. ✦ Brief description of event including the severity of flooding, inland extent, associated weather, and the effects of tides. A watch may include: ✦ A Heavy Surf Advisory. ✦ A definition of watch (time permitting). ✦ An appropriate call to action (time permitting). A Coastal Flood Watch is either replaced by another Coastal Flood Watch, upgraded to a Coastal Flood Warning, updated by a Coastal Flood Statement (every six hours), or canceled by a Coastal Flood Statement.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Statements			
Coastal Flood Statement	___CFS___	Local Weather Service Office	This product is issued to keep the public informed of the status of existing coastal flood watches and/or warnings. (It is issued at least every six hours after the issuance of a watch or warning until the watch or warning is canceled.) The Coastal Flood Statement is used to cancel a watch or warning or to clear part of a watch or warning area that is no longer threatened by coastal flooding. It also provides the latest information on local conditions, an overview of the threat for the entire coastline, and current tidal information. A Coastal Flood Statement includes the same information as the watch or warning that the statement updates **and** the status of the watch/warning. ✦ If clearing an area from the watch or warning, the statement will describe the area being removed and the reasons for the removal. ✦ If canceling the entire watch/warning, it states the cancellation and the reason for the cancellation. ✦ If the watch/warning is being absorbed into another product, the statement explains the changes and refers the user to the new information source.
Marine Weather Statement	___MWS___	Local Weather Service Office	This statement is issued for less severe episodes or when conditions are uncertain. The MWS also may be used to issue a Heavy Surf Advisory. The MWS is updated at least every six hours until canceled.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings			
Coastal Flood Warning	___CFW____	Local Weather Service Office	This product is used to inform the public that coastal flooding, posing a serious threat to life and property, is occurring, is imminent, or is expected within approximately the next 12 hours. A warning includes the: ✦ Time of next update. ✦ Geographical area covered. ✦ Valid time of warning. ✦ Brief description of event including severity of flooding, inland extent, associated weather, and effects of tides. A warning may include: ✦ A Heavy Surf Advisory. ✦ A definition of the warning (time permitting). ✦ An appropriate call to action (time permitting). A Coastal Flood Warning is either replaced by another Coastal Flood Warning, updated by a Coastal Flood Statement (every six hours), or canceled by a Coastal Flood Statement.
Heavy Surf Advisory		Coastal Local Weather Service Office	This is a forecast of heavy (high) surf that may pose a threat to life or property. These advisories may be issued alone within a Marine Weather Statement or in conjunction with Coastal Flood Watches or Warnings.
Discussions N/A			

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Short Term Forecasts	___NOW___	Coastal Local Weather Forecast Office	These forecasts are designed to provide the public with a plain language description of current and short term weather and flooding conditions for the issuing office's county warning area. The coastal flood information contained in the forecasts supplements—does not replace—the Coastal Flood Statement.

LAKESHORE FLOODING

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks N/A			
Watches N/A			
Statements Lakeshore Statement	___LSH___	Open Lake Responsible Local Weather Service Office	This product is issued as a followup to warnings and to alert the public of potentially hazardous conditions. It also is issued to provide advance notice of a developing situation that may require later issuance of a Lakeshore Warning and to cancel a warning when conditions improve. Statements include: ✦ The latest information available on local conditions. ✦ An overview on the threat to the shoreline community. A statement is issued at least every 6 hours after a warning is issued (more frequently if conditions are changing rapidly).

PRODUCTS

LAKESHORE FLOODING

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings Lakeshore Warning	___LSH___	Open Lake Responsible Local Weather Service Office	This is issued for lakeshore flooding that is occurring or imminent within approximately the next 12 hours and that poses a serious threat to life or property. In unusual circumstances that require longer advance notice for public response, the warning lead time may be extended to 24 hours. The Lakeshore Warning provides the following information on the extent, location, and duration of the event: ✦ Geographical area. ✦ Effective time of the warning in hours or in general terms (e.g. this afternoon, this evening). ✦ Definition of warning. ✦ Severity of the flooding (including water levels, if available). ✦ Call to action. If there are changes in the warning area, a new Lakeshore Warning will be issued.
Discussions N/A			
Short Term Forecasts N/A			

EXTRATROPICAL CYCLONES

DEFINITION

Most of the storms that affect U.S. weather are extratropical. These are deep, low-pressure storms that:

- ✦ Form outside the tropics off the Pacific coast, in the Gulf of Mexico, over the Atlantic Ocean, or in the Great Lakes.
- ✦ Cover a larger area (700–1000 miles across) than tropical cyclones.
- ✦ Have a storm center that is colder than the surrounding air.
- ✦ Have their strongest winds in the upper atmosphere.

CHARACTERISTICS

Under ideal wind and temperature conditions, a coastal low-pressure system deepens rapidly. Because these storms form over water, which has a smoother surface than land, wind speeds pick up rapidly. Fewer weather data tend to be available from the ocean areas, so detection may lag behind storm development. Extratropical cyclones tend to *deepen quickly near the shore*, which shortens the time available for communities to respond.

Hazards from extratropical cyclones include:

- ✦ Swells, storm surges, and huge waves that pound the coastline.
- ✦ Very high winds generated by strong gradients of pressure.
- ✦ Coastal flooding.
- ✦ Heavy rains, flooding, and flash flooding.
- ✦ Heavy snow.
- ✦ Mud slides.
- ✦ Downbursts.
- ✦ Tornadoes.

Refer to the fact sheets on coastal floods, winter storms, and tornadoes for more information on these hazards.

HISTORICAL EXAMPLES

- The extratropical coastal cyclone named the 1993 Superstorm formed in the Gulf of Mexico and affected 22 States. It produced deadly 12-foot storm surges that flooded the gulf coast of Florida; generated thunderstorms, gale-force winds gusting to over 80 m.p.h. and tornadoes; spread blizzard conditions over a massive area from the Southeast through New England; and then plummeted the eastern half of the U.S. into deep-freeze temperatures. Over 400 people died and damage estimates exceeded $2 billion.
- The October 1991 storm that formed in the Atlantic had devastating effects on the coastlines of New England. It damaged sea walls, closed roads, and produced flooding that caused massive damage and injuries over a large area from New Jersey northward.
- In February 1986, a series of coastal storms formed in the Pacific and struck California, producing gale-force winds and heavy flooding. Thirty-nine counties were declared disaster areas, and at least 15 people died because of drowning, mud slides, and collapsing buildings. Flooding washed out roads, bridges, dams, and railroad beds; destroyed homes and businesses; and caused massive power outages. Preliminary property loss estimates exceeded $350 million.

PRODUCTS

The National Weather Service does not issue any products unique to extratropical cyclones. Refer to fact sheets on winter storms, thunderstorms, coastal floods, or riverine floods, as necessary, for products related to extratropical cyclones.

TROPICAL CYCLONES

DEFINITION

Tropical cyclones are coastal storms that:

- ✦ Form over a tropical ocean.
- ✦ Cover a smaller area (200–500 miles across) than extratropical cyclones.
- ✦ Have a storm center warmer than the surrounding air.
- ✦ Have the strongest winds at about 10,000 feet.

Tropical cyclones are categorized by wind speed as shown in the table below.

CATEGORY	*WIND SPEED*
Tropical Depression	Maximum sustained winds near the surface less than 39 m.p.h.
Tropical Storm	Winds of 39–73 m.p.h.
Hurricane	Winds of 74 m.p.h. or more.

(NOTE: A hurricane is called a **typhoon** if formed in the western Pacific, and a **cyclone** if formed in the Indian Ocean.)

In the Northern Hemisphere, intense tropical cyclones are called hurricanes, a term that echoes colonial Spanish and Caribbean Indian words for evil spirits and big winds. The storms are products of the tropical ocean and atmosphere, powered by the easterly trades and temperate westerlies and their fierce energy. Around the core, winds blow with lethal velocity, and the ocean develops inundating surge. As they move ashore, tornadoes may descend from the advancing thunderclouds.

This fact sheet provides planning and preparedness information on hurricanes, as the other tropical cyclones present similar hazards, yet typically are not as severe.

CHARACTERISTICS

Hurricanes are generated by the rising and cooling of humid air over the ocean. They need the following ingredients to develop:

- Ocean water over 80^0F and about 200 feet deep.
- Winds converging near the water surface.
- Unstable air, so that the warm air continues to rise.
- Humidity up to about 18,000 feet to supply heat energy.
- Winds moving in one direction to move the storm along without breaking it up.
- Upper atmosphere high pressure to help move out the rising air of the storm.

Hurricane winds blow counterclockwise around the center, or eye, of the storm, and air currents carry the storm along. Most Northern Hemisphere hurricanes move from east to west in the trade winds. They may turn north or northwest out in the Atlantic, then curve toward the northeast. Storms that move up the east coast usually pick up speed around North Carolina and may travel at speeds up to 70 m.p.h.

Hurricanes are classified using the following Saffir-Simpson Hurricane Damage Potential Scale, based on central barometric pressure and wind speed. The Saffir-Simpson Scale is shown in the table below.

CATEGORY	*CENTRAL PRESSURE (MILLIBARS)*	*CENTRAL PRESSURE (INCHES)*	*WINDS (MPH)*	*WINDS (KTS)*	*DAMAGE*
1	980	28.94	74–95	64–83	Minimal
2	965–979	28.50–28.93	96–110	84–96	Moderate
3	645–964	27.91–28.49	111–130	97–113	Extensive
4	920–944	27.17–27.90	131–155	114–135	Extreme
5	< 920	< 27.17	> 155	> 135	Catastrophic

Hydrometeorological hazards associated with hurricanes include:

- **Coastal flooding** caused by a storm surge.
- **Windstorms** due to extremely strong winds.
- **Riverine flooding** caused by heavy rains.
- **Tornadoes.**

These hazards are described on the next page. Refer to the fact sheet for each hazard for more information.

CHARACTERISTICS

Historically, the worst damage from hurricanes comes from coastal flooding caused by storm surge. A storm surge is an abnormal rise in water level caused by wind and low-pressure forces. The lower the pressure of the storm, the greater the height of the storm surge. High winds and low pressure can build a wall of water out in the ocean about 10 feet high. The highest surges in the United States have reached 20 feet. When the surge reaches land, the wall of water can cause extensive coastal flooding.

Hurricane-force winds also can cause extensive damage and death. The strongest winds in a hurricane occur from 10 to 30 miles from the center of the eye, in a region called the **eye wall**. Winds that extend outward from the eye wall in the front right quadrant are the most devastating. Precursor winds will affect land well before the most damaging winds of the eye.

When a hurricane reaches land, it begins to weaken as it loses its warm-water energy source and encounters greater surface friction over land. This weakening process is gradual, so even though wind speeds may be reduced by 50 percent within 12 hours, hurricane-force winds can penetrate far inland in that timeframe. Additionally, tropical storm-force winds can extend far beyond the storm center and, although weaker, can cause significant damage.

Coastal and inland jurisdictions affected by hurricane winds should anticipate:

- ✦ Widespread damage to homes, especially mobile homes, and businesses.
- ✦ Extensive tree damage along roadways, which may inhibit or block access.
- ✦ Extensive damage to electric and telephone lines.
- ✦ Damaged and/or destroyed signs and traffic-control devices.
- ✦ The potential for utility line breaks, if large trees are uprooted.
- ✦ Damaged radio and television towers.

Widespread torrential rains of six to 12 inches are not uncommon in hurricanes and can produce deadly and destructive floods. Riverine flooding is a major threat to areas well inland.

Hurricanes may also spawn tornadoes, which add to the hurricane's destructive power. These tornadoes most often occur in the thunderstorms embedded in rain bands out from the right front quadrant of the hurricane, although they can also occur near the eye wall.

HISTORICAL EXAMPLES

- Hurricane Andrew, in 1992, caused an estimated $25 billion in damage, making it the most expensive hurricane in U.S. history. Wind gusts were estimated to be at least 175 m.p.h. in south Florida.
- Hurricane Agnes, in 1972, fused with another storm system, producing floods in the Northeastern U.S. that contributed to 122 deaths and $6.4 billion in damage.
- Long after the winds of Hurricane Diane in 1955 subsided, the storm brought floods to Pennsylvania, New York, and New England that contributed to nearly 200 deaths and $4.2 billion in damage.

PRODUCTS

A valuable source of information is your community's Hurricane Evacuation Study, if one has been completed. Contact the local WSFO to check if a study has been completed for your area and to obtain a copy.

The table below and on the next pages lists NWS products that can provide planning and preparedness information on tropical cyclones.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Tropical Weather Outlooks	___TWO___ MIATWOAT (1-5)* MIATWOEP (1-5)* HNLTWOCP (1-5)* SJUTWOSJU	National Hurricane Center Central Pacific Hurricane Center San Juan, PR NWS Office	The Tropical Weather Outlook is prepared by the National Hurricane Center (NHC) and Central Pacific Hurricane Center (CPHC). (Note: The last two letters in the identifiers indicate location—e.g., AT is Atlantic, EP is Eastern Pacific). It is issued by San Juan in a Spanish translation. It should include the system's location (in either general terms or map coordinates), status, and change in status.

*(1-5) indicates the consecutive number of issuances for the day.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Watches N/A			Hurricane Watches are contained in the Public Advisories.
Statements Hurricane Local Statements	___HLS___	Local NWS Office	These products are issued at regular and frequent intervals. When a tropical storm or hurricane is close to the coast, the products are issued at 2 or 3 hourly intervals and more frequently if information and circumstances warrant. These statements contain the following: ✦ A concise lead sentence or headline. ✦ A sentence detailing which counties, parishes, or cities are included. ✦ Watches and warnings in effect and counties or parishes to which they apply.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Public Advisories Tropical Depression Advisory Tropical Storm Advisory Hurricane/ Typhoon Advisory	 MIATCPAT (1-5) MIATCPEP (1-5) HNLTCPCP (1-5)	 National Hurricane Center	Scheduled and issued every six hours. The type of advisory depends upon the strength of the tropical cyclone. A tropical depression advisory will be issued for winds up to 33 knots (38 m.p.h.). A tropical storm advisory will be issued for winds 34 knots to 63 knots (39 to 73 m.p.h.). A hurricane/typhoon advisory is issued for wind 64 knots (74 m.p.h.) or greater. All advisories shall include the: ✦ Location of the center of the tropical cyclone. ✦ Present movement. ✦ 24-hour forecast movement. ✦ Uncertainties in either location or movement. ✦ Wind, central pressure, and storm surge to describe the storm. ✦ Expected time of onset of tropical storm or hurricane/typhoon force winds. ✦ Intensity forecasts. ✦ Inland effects of tropical cyclones to include threat of strong winds, and anticipated rainfall amounts, including the potential for flooding.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Public Advisories (Continued) Tropical-Cyclone Forecast/ Advisory	MIATCPAT (1-5) MIATCPEP (1-5) HNLTCPCP (1-5)	National Hurricane Center Central Pacific Hurricane Center	Because intermediate advisories are designed to update earlier scheduled advisories, their format and content may be less formal and less complete. The content of special advisories is generally similar to that of the scheduled advisory. This product is scheduled and issued every six hours. It provides invaluable wind field information to emergency managers, local decisionmakers, and other users who must make preparations and take response actions for the inland wind effects of tropical cyclones. Accordingly, inland interests should be appraised of the availability of this product and should be encouraged to use it in concert with the public advisories for decisionmaking purposes. Advisories contain 12-, 24-, 36-, 48-, and 72-hour forecast positions.
Warnings N/A			Hurricane Warnings are contained in the Public Advisories.
Strike Probability Forecast	___SPF___	National Hurricane Center	This product describes the probability of tropical cyclone conditions and is issued in tabular form at the regularly scheduled public advisory times and when special public advisories are issued. The probabilities, which are based on the official forecast track and are carried in advisories, are issued when the 72-hour position approaches the coast.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Strike Probability Forecast (Continued)			Probabilities are computed shortly after synoptic times for the periods 0-24, 24-36, 36-48, and 48-72 hours. A total probability for the 72 hours is shown in the last column representing a total of all forecast products. Probabilities are not issued for the west coast of the continental United States or Hawaii. If the probability for a location is less than one percent, an "X" will be indicated in the table. If probabilities are not issued, a statement indicating this exclusion will be contained in both the public advisory and tropical cyclone forecast/advisory.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Discussions			
Tropical Weather Discussion	____TCD___	National Hurricane Center and Central Pacific Hurricane Center	This product explains the forecaster's reasoning behind the analysis and forecast of tropical cyclone characteristics. These discussions normally include prognostic reasoning, objective techniques employed, and guidance used.
Preliminary Post-Storm Report	___PSH___	Local NWS Office	These reports provide details of the storm's impact, including accounts of unusual storm damage. Reports will include the: ✦ Highest recorded 1-minute sustained surface wind, peak gust, and date/time of occurrence. ✦ Lowest sea level pressure recorded, including date/time of occurrence. ✦ Storm total rainfall amount and duration, to include 1-, 6-, 12-, 24-hour amounts identifying date/time of occurrence. ✦ Maximum storm tide heights and storm surge heights in feet above normal. ✦ Extent of beach erosion if appropriate. ✦ Flooding/flash flooding within the area of responsibility. ✦ Tornadoes within the area of responsibility. ✦ Preliminary storm effects, such as deaths, injuries, dollar damage amounts, number of residents evacuated, etc.
Short Term Forecast	___NOW___	Local NWS Office	The NOW is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

WINTER STORMS

DEFINITIONS

Winter storms are extratropical storms that bring cold temperatures, precipitation, and possibly, high winds.

The following conditions can occur during winter storms:

- **Snow** is defined as a steady fall of snow for several hours or more.
- **Heavy snow** generally means:
  - Snowfall accumulating to 4 inches or more in depth in 12 hours or less.
  - Snowfall accumulating to 6 inches or more in depth in 24 hours or less.
- **Snow squalls** are periods of moderate to heavy snowfall, intense, but of limited duration, accompanied by strong, gusty surface winds and possibly lightning.
- A **snow shower** is a short duration of moderate snowfall.
- **Snow flurries** are an intermittent light snowfall of short duration with no measurable accumulation.
- **Blowing snow** is wind-driven snow that reduces surface visibility. Blowing snow can be falling snow or snow that already has accumulated but is picked up and blown by strong winds.
- **Drifting snow** is an uneven distribution of snowfall/snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.
- A **blizzard** means that the following conditions are expected to prevail for a period of 3 hours or longer:
  - Sustained wind or frequent gusts to 35 m.p.h. or greater.
  - Considerable falling and/or blowing snow reducing visibility to less than 1/4 mile.
- **Freezing rain or drizzle** occurs when rain or drizzle freezes on surfaces, such as the ground, trees, power lines, motor vehicles, streets, highways, etc.
- The term **ice storm** is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations.
- **Sleet** is pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes.
- A **freeze** occurs when the surface air temperature is expected to be 32^{o}F or below over a widespread area for a climatologically significant period of time. Use of the term usually is restricted to advective situations or to occasions when wind or other conditions prevent frost.
- **Frost** describes the formation of thin ice crystals on the ground or other surfaces in the form of scales, needles, feathers, or fans. Frost develops under conditions similar to dew, except the temperatures of the Earth's surface and earthbound objects fall below 32^{o}F. Because frost is primarily an event that occurs as the result of radiational cooling, it frequently occurs with a thermometer-level temperature in the mid-30s.
- **Wind chill** describes the cooling of a body by air motion. Increased wind speeds accelerate heat loss from exposed skin. As a general rule, the threshold for potentially dangerous wind chill conditions is about -20^{0}F.

CHARACTERISTICS

The development of a winter storm requires:

- **Cold air.** Subfreezing temperatures (below 32^0F, 0^0C) in the clouds and near the ground are needed to make snow and/or ice.
- **Moisture.** The air must contain moisture in order to form clouds and precipitation. Air blowing across a body of water, such as a large lake or an ocean, is an excellent source of moisture.
- **Lift.** A mechanism to raise the moist air to form the clouds and cause precipitation must be present. Lift may be provided by any or all of the following:
  - The flow of air up a mountainside.
  - Fronts, where warm air collides with cold air and rises over the cold dome.
  - Upper level low pressure troughs.

The hazards involved with winter storms include:

- **Strong winds.** Sometimes winter storms are accompanied by strong winds, creating wind-driven snow, severe drifting, and dangerous wind chill. Strong winds can knock down trees, utility poles, and power lines. Storms near the coast can cause coastal flooding and beach erosion. In the West and Alaska, winds descending off the mountains can gust to 100 m.p.h. or more, causing extensive damage.
- **Extreme cold.** Extreme cold may accompany or follow a winter storm. Freezing temperatures can cause bursting pipes, crop damage, river ice jams and subsequent flooding, and frostbite or hypothermia due to exposure. Refer to the fact sheet on extreme cold for more information.
- **Precipitation.** The type of precipitation accompanying a winter storm depends on surface and atmospheric conditions. Ice and snow accumulation can knock down trees and power lines, disrupting power and communication for days. Accumulated winter precipitation also causes hazardous traffic conditions and disrupts transportation routes, especially in warmer climates where accumulation is uncommon. This can leave travelers and rural residents stranded and stop the flow of supplies for a region.
- **Heavy snow and blizzard conditions.** During a blizzard, snow and strong winds combine to produce a blinding snow (near zero visibility), deep drifts, and life-threatening wind chill. Along with other hazards of accumulated ice and snow and extreme cold, the reduced visibility can lead to extreme transportation problems and increase fatalities due to exposure. Areas around the Great Lakes are affected by **lake-effect storms.** Lake-effect storms form as arctic air is drawn from the north and moves across the lakes, drawing moisture from the unfrozen water. These storms typically form snow squalls and deliver heavy snow to a localized area.

HISTORICAL EXAMPLES

- The 1993 Superstorm dumped massive amounts of snow from the Gulf Coast States northeastward through New England. Many cities experienced record low barometric pressure readings, indicative of a hurricane-force storm. In the South, many areas received record-breaking snowfalls (e.g., Birmingham, Alabama received 13 inches of snow). The volume of water that fell as snow may be unprecedented—estimated at 44 million acre-feet. At least 243 deaths were attributed to the storm, and 48 persons were lost at sea. For the first time, every major airport on the east coast was closed at one time or another by the storm. Over 3 million customers were without electricity. Wind gusts were recorded at 110 mph in Florida. Damages were estimated at $2 billion.
- An unexpected spring blizzard in May 1986 trapped 13 people on Mt. Hood, Oregon. Nine died, two walked to safety, and two were rescued after being buried under 4 feet of snow. One of the rescued survivors later had his lower legs amputated due to frostbite.

PRODUCTS

The table on the following pages lists NWS products that can provide planning and preparedness information on winter storms. Refer to the fact sheets on extratropical coastal cyclones and extreme cold for information on other products.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Winter Storm Outlook	___SPS___	Local NWS Office	This product may be issued when there is a good chance of a major winter storm beyond the point normally covered by a watch (3-5 days). The prime objective of the outlook is to inform users of the potential of the upcoming event. The need for an outlook depends on: ✦ NCEP guidance. ✦ High confidence that a large-scale storm will occur. ✦ Need for advance public notice (e.g., national holiday or regionally significant event associated with widespread travel).
Watches Winter Storm Watch	___WSW___	Local NWS Office	This product is issued when conditions are favorable for hazardous winter weather conditions to develop over part or all of the forecast area, but the occurrence is still uncertain. It is intended to provide enough lead time so those who need to take action can do so. A Winter Storm Watch includes the: ✦ Affected area. ✦ Reason the watch was issued. ✦ Potential snowfall amounts and ice accumulations. ✦ Explanation of a watch and the uncertainty involved. ✦ Precautions, call-to-action statements, and potential impact. A Winter Storm Watch either evolves into a Winter Storm Warning or advisory or it is canceled. (See Special Weather Statement.)

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Statements			
Special Weather Statement	___SPS___	Local NWS Office	This statement is issued at frequent intervals: ✦ Before active weather develops to outline expected conditions, affected areas, timing, and appropriate response actions. ✦ When the event begins to keep users informed about the current aspects of the storm, to heighten awareness, and ensure a proper response. ✦ To cancel Winter Storm Watches, warnings, and advisories, including the reason for ending the advisory, warning or watch, and details about the history of the event (snow accumulations, height of snow drifts, amount of freezing rain, general road conditions, etc.).
Severe Weather Statements	___SVS___	Local NWS Office	This statement is used during blizzard situations for greater emphasis on the life-threatening nature of these dangerous storms. (It contains the same information as the Special Weather Statement.)
Advisories/ Warnings			
Winter Storm Warning Heavy Snow Warning Ice Storm Warning	___WSW___	Local NWS Office	Warnings are issued when hazardous winter weather is occurring, imminent, or highly likely over part or all of the forecast area. They are reissued whenever there is a change to the timing, areal extent, or expected condition. (If the event is expected to be limited to a specific condition, the forecaster can issue a specific warning—e.g. Heavy Snow Warning or Ice Storm Warning.)

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings (Continued)			Warnings include the: ✦ Affected area. ✦ Potential snowfall amounts, ice accumulations, wind chill, etc. ✦ Timing of the event (beginning, ending, time of heaviest precipitation or worst conditions, duration, etc.). ✦ Reason the warning was issued. ✦ Definition of a warning (especially if the event has not yet begun). ✦ Safety rules and call-to-action statement.
Winter Weather Advisory	___WSW___	Local NWS Office	An advisory is issued for winter weather situations that cause significant inconveniences but do not meet warning criteria and, if caution is not exercised, could lead to life-threatening situations. An advisory is issued for significant events that are occurring, are imminent, or have a very high probability of occurrence. An advisory should be reissued when there is a change in timing, areal extent or expected condition. If the forecaster is confident that only one type of event will occur, then an event-specific advisory can be issued (e.g., Freezing Drizzle Advisory or Blowing Snow Advisory). An advisory includes the: ✦ Affected area. ✦ Potential snow amount, ice accumulations, wind chill, etc. ✦ Timing of the event (beginning, ending, time of heaviest precipitation or worst conditions, duration, statement about skill of timing, etc.). ✦ Reason for issuing the advisory. ✦ Precautions, call-to-action statement, and potential impact.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings (Continued)			Complex weather systems may require that watches, warnings, and advisories be in effect for a variety of times and places within the Local Weather Service Office area of responsibility. In this case, all watches, warnings, and advisories are combined in the same product. Warnings are listed first, advisories are listed second, and watches last. Warnings and advisories are canceled when the weather event fails to materialize or tapers off so that the criteria no longer are met. (See Special Weather Statement for details.)
Discussions N/A			
Short Term Forecasts	___NOW___	Local NWS Office	The primary purpose of the Short Term Forecast is to provide users with a concise, non-technical, short term forecast of ongoing hydrometeorological conditions for the office's County Warning Areas (CWA). Issuance should be tied to events of significant interest as well as local media requirements. Frequency of issue should increase as a result of rapidly changing conditions. (As a general guideline, issuance should occur every hour or so when there is precipitation and more frequently during changeable or severe conditions forecasts.) The forecast includes: ✦ Hazardous conditions (e.g., winter weather including snow, freezing rain, wind, and wind chill). ✦ Non-hazardous conditions (e.g., precipitation anywhere in the office's CWA, wind and temperature variations, effects of frontal passage, and state of the sky). ✦ A brief call-to-action statement, as appropriate, to further highlight significant or hazardous conditions.

EXCESSIVE COLD

DEFINITION

What is considered an excessively cold temperature varies according to the normal climate of a region (e.g., in a relatively warm climate, temperatures just below or at freezing can be hazardous). Excessive cold may accompany or follow winter storms—or can occur without storm activity.

CHARACTERISTICS

Freezing temperatures can cause problems with burst pipes and automobiles that will not start, but the greatest danger is to people. Prolonged exposure to extreme cold can lead to frostbite, hypothermia, and death.

- **Frostbite** is damage to body tissue caused by that tissue being frozen. Frostbite causes a loss of feeling and a white or pale appearance in the extremities.
- **Hypothermia** is low body temperature. Normal body temperature is 98.6^0F. When body temperature drops to 95^0F, however, immediate medical help is needed. Hypothermia also can occur with prolonged exposure to temperatures above freezing.

Of winter deaths attributed to exposure to cold:

- 50 percent are people over 60 years old.
- Over 75 percent are male.
- About 20 percent occur in the home.

Cold air temperatures combined with wind create the wind-chill effect. Wind chill is based on the rate of heat loss from exposed skin caused by combined effects of wind and cold. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Forecasters use a **wind-chill index** as a guide to heat loss resulting from wind and cold. Wind chills for given temperatures and wind speeds are shown in the table on the next page.

WIND-CHILL INDEX

	TEMPERATURES						
WIND	30	25	20	15	10	5	0
15 m.p.h.	9	2	-5	-11	-18	-25	-31
20 m.p.h.	4	-3	-10	-17	-24	-31	-39
25 m.p.h.	1	-7	-15	-22	-29	-36	-44
30 m.p.h.	-2	-10	-18	-25	-33	-41	-49

HISTORICAL EXAMPLES

- Four soldiers participating in Army Ranger training died from hypothermia in February 1995 after spending hours in chest-deep waters in a Florida swamp. Air temperatures were well above freezing, but prolonged exposure to the chilly water severely lowered their body temperatures.
- The 1993 Superstorm dumped massive amounts of snow from the Gulf Coast States northeastward through New England. Many cities experienced record low barometric pressure readings, indicative of a hurricane-force storm. In the South, many areas received record-breaking snowfalls (e.g., Birmingham, Alabama received 13 inches of snow). Fifty inches of snow fell at Mt. Mitchell in North Carolina. More than 100 hikers were rescued from the North Carolina and Tennessee mountains, many suffering from exposure, as wind chill in the southern Appalachians dropped as low as -20^0F. In Alabama alone, six people died of exposure after abandoning vehicles. Damages were estimated at $2 billion.
- In December 1992, a couple and their 4-month old baby got caught in their pick-up truck during a blizzard in Nevada. They waited 2 days for help, then set out on foot. After 2 days of walking, the woman and baby stayed in a cave and the man continued walking for 3 more days before reaching help. The baby survived unscathed, but the parents lost toes to frostbite and spent 2 months in wheelchairs and casts regaining their strength and the use of their legs.

PRODUCTS

The table below and on the next page lists NWS products that can provide planning and preparedness information on excessively cold conditions. Refer to the fact sheet on winter storms for other products.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks N/A			
Watches Winter Storm Watch	___WSW___	Local NWS Office	This watch is issued 12–24 hours in advance of onset and includes the: ✦ Area affected. ✦ Reasons for the watch. ✦ Potential impacts. ✦ Explanation of a watch and uncertainty. ✦ Precautions and a call-to-action statement.
Statements Special Weather Statement	___SPS___	Local NWS Office	This statement highlights the impending cold temperatures.
Cancellation of Watch	___SPS___	Local NWS Office	This cancels existing watches.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings			
Wind Chill Advisory	___WSW___	Local NWS Office	A Wind Chill Advisory is issued when conditions produce a non-dangerous situation that is a major inconvenience. It contains information on the: ✦ Area affected. ✦ Potential temperatures, wind chills, ✦ general impacts, and general conditions. ✦ Timing of events—beginning, peak, and ending. ✦ Reasons for the warning. ✦ Advisory definition. ✦ Precautions and call-to-action statement.
Wind Chill Warning	___WSW___	Local NWS Office	A Wind Chill Warning is issued when conditions are dangerous. It contains information on the: ✦ Area affected. ✦ Potential temperatures, wind chills, ✦ general impacts, and general conditions. ✦ Timing of events—beginning, peak, and ending. ✦ Reasons for the warning. ✦ Advisory definition. ✦ Precautions and call-to-action statement.
Discussions N/A			
Short Term Forecasts			
Short Term Forecast	___NOW___	Local NWS Office	This is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

FOG

DEFINITION

Fog is defined as water droplets suspended in the air at the Earth's surface. Fog is often hazardous when the visibility is reduced to 1/4 mile or less.

CHARACTERISTICS

Thick fog reduces visibility, creating a hazard to motorists as well as to air traffic. Airports may close because of heavy fog.

The intensity and duration of fog varies with the location and type of fog—from early morning ground fog that burns off easily to prolonged valley fog that lasts for days. Generally, strong winds tend to prevent fog formation. The table on the next page summarizes several scenarios for the formation, intensity, and duration of fog.

CHARACTERISTICS

TYPE OF FOG	*FACTORS*	*DESCRIPTION*	*EFFECTS*
Ground Fog	✦ Clear nights. ✦ Stable air (winds less than 5 m.p.h.). ✦ Small temperature dewpoint spread.	Heat radiates away from the ground, cooling the ground and surface air. When the air cools to its dewpoint, fog forms— usually a layer of less than 100–200 feet.	Common in many areas, ground fog burns off by morning sun.
Valley Fog	✦ Cold surface air and weak winter sun. ✦ May follow a winter storm or prolonged nighttime cooling.	Fog can build to a height of more than 1,500 feet. Weak sun may evaporate lower levels of the fog but leave upper levels in place.	Found in valleys (especially in the West) in winter, valley fog can last for days, until winds are strong enough to push out the cold air.
Advection Fog	✦ Horizontal wind. ✦ Warm, humid air. ✦ Winter temperatures.	Wind pushes warm humid air over the cold ground or water, where it cools to the dewpoint and forms fog.	Advection fog can cover wide areas of the central U.S. in winter. It may be sufficient to close airports.
Upslope Fog	✦ Winds blowing up hills or mountains. ✦ Humid air.	As humid air is pushed up hills and mountains, it cools to its dewpoint and forms fog, which drifts up the mountain.	Upslope fog is common and widespread in the Great Plains, where land slopes gently upward toward the Rockies.
Sea Smoke, Steam Fog	✦ Body of water. ✦ Air much colder than water. ✦ Wind.	As cold air blows over warmer water, water evaporates into the cold air, increasing the humidity to the dewpoint. Vapor condenses, forming a layer of fog 1 to 2 feet thick over the water.	Forms on fall days over ponds and streams.
Precipitation Fog	✦ Warmer rain. ✦ Cooler air.	Some rain evaporates, and the added vapor increases the air to its dew point. The vapor then condenses into fog.	Precipitation fog forms on cool, rainy days.

HISTORICAL EXAMPLE

In March 1995, fog caused a 100-car wreck on a seven-mile bridge over Mobile Bay in Alabama, leaving 87 people injured and one person dead.

PRODUCTS

The table on the following pages lists products that can provide planning and preparedness information on fog.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks			
Fog Outlook	___SPS___	Local NWS Office	This product is issued when there is a good chance of fog occurring. It is issued at least 12 hours in advance. The primary goal of an outlook is to give advance notice. It includes the: ✦ Area of impact. ✦ Hazards. ✦ Timeframes.
Watches			
Fog Watch	___NPW___	Local NWS Office	A watch is issued when conditions are favorable for fog to develop. It covers 12-24 hours in advance. A watch includes the: ✦ Area affected. ✦ Reason for the watch. ✦ Potential impact. ✦ Explanation of the watch and uncertainty. ✦ Precautions and call to action.
Statements			
Special Weather Statement	___SPS___	Local NWS Office	A Special Weather Statement is issued to cancel a Non-Precipitation Watch.
Advisories			
Fog Advisory	___NPW___	Local NWS Office	A Fog Advisory should be issued when existing or imminent fog covers part or all of the forecast area and poses a mere inconvenience. An advisory includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of events—beginning, ending, peaking, and weakening. ✦ Reasons for the advisory. ✦ Advisory definition. ✦ Precautions and call to action.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Warnings Fog Warning	___NPW___	Local NWS Office	A Fog Warning should be issued when existing or imminent fog covers part or all of the forecast area and poses a threat to life and property. A warning includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of events—beginning, ending, peaking, and weakening. ✦ Reasons for the advisory. ✦ Advisory definition. ✦ Precautions and call to action.
Discussions N/A			
Short Term Forecasts	___NOW___	Local NWS Office	The NOW forecast is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. The NOW gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

EXCESSIVE HEAT

DEFINITION

What is considered excessive heat varies according to the normal climate of a region. Tropical air masses can raise summer temperatures high above the average for an area. Sudden rises in temperature—when people don't have a chance to acclimatize—or prolonged heat waves increase death rates. People die from excessive heat.

Excessive heat occurs from a combination of high temperatures (significantly above normal) and high humidities. At certain levels, the human body cannot maintain proper internal temperatures and may experience heat stroke. The "Heat Index" (HI) is a measure of the effect of the combined elements on the body.

A daytime HI reaching 105°F or above with nighttime lows at or above 80°F for two consecutive days may significantly impact public safety and, therefore, generally requires the issuance of an advisory or warning by local NWS offices.

CHARACTERISTICS

There are some practical problems that can result from high temperatures, such as overheated car engines, "brown-outs" from overuse of electricity for air conditioning, and changes in airplanes' performance. As with extreme cold, however, the major danger of extreme heat is to humans and animals. Heat-related ailments can range from annoying conditions to life-threatening situations, such as:

- **Heat Cramps**. Muscle cramps, especially in the legs after exercising, are caused by imbalances in body salt.
- **Fainting.** Exercising in the heat can cause a rapid drop in blood pressure, resulting in fainting.
- **Heat Exhaustion.** Loss of fluid and salt through excessive sweating can lead to dizziness, overall weakness, and a rise in body temperature. This can result from normal activity during several days of a heat wave or strenuous activity in extreme temperatures.
- **Heatstroke.** If heat exhaustion is not treated, the body temperature may rise to 105^0F or more and heatstroke may occur. A heatstroke victim may exhibit lethargy, confusion, or unconsciousness and is at risk of dying.

CHARACTERISTICS

When the air is humid, the "apparent temperature" is even higher. Forecasters use the **Humidity Index** to show apparent temperature. The chart below shows the Humidity Index.

HUMIDITY INDEX

	TEMPERATURES							
HUMIDITY	75	80	85	90	95	100	105	110
40%	74	79	86	93	101	110	122	135
50%	75	81	88	96	107	120	135	150
60%	76	82	90	100	114	132	149	163
70%	77	85	93	106	124	144	161	--
80%	78	86	97	113	136	157	166	--
90%	79	88	102	122	150	170	--	--

HISTORICAL EXAMPLES

- In July 1995, a heat wave hit the Eastern and Midwestern United States. Over 475 heat-related deaths occurred in Chicago alone.
- In July 1993, a heat wave hit the Eastern United States, causing power shortages and many illnesses and deaths. For example, between July 6 and 14, there were 118 heat-related deaths in Philadelphia.
- In July 1980, a heat wave hit the Midwestern United States. In Kansas City and St. Louis, 1,448 people were killed by the heat.
- The U.S. Centers for Disease Control estimates that 5,379 people have died from excessive heat between 1979 and 1992. This is an average of 413 deaths per year.

PRODUCTS

The table below and on the next page lists NWS products that can provide planning and preparedness information on extreme heat conditions.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Outlook for Excessive Heat	___SPS___	Local NWS Office	In extreme circumstances an outlook can be issued to include the: ✦ Advanced notice of excessive heat. ✦ Expected conditions. ✦ Locations. ✦ Timeframes.
Watches Excessive Heat Watch	___NPW___	Local NWS Office	This watch is issued 12–24 hours in advance of onset and includes the: ✦ Area affected. ✦ Reasons for the watch. ✦ Potential impacts. ✦ Explanation of a watch and uncertainty. ✦ Precautions and call-to-action statement.
Statements Cancellation of Watch	___SPS___	Local NWS Office	This product cancels an existing watch.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings			
Excessive Heat Advisory	___NPW___	Local NWS Office	An Excessive Heat Advisory is issued when the conditions produce a non-dangerous situation that is a major inconvenience. It includes the: ✦ Area affected. ✦ Potential temperatures, heat index, general impacts, and general conditions. ✦ Timing of events, including the beginning, peak, and ending. ✦ Reasons for the advisory. ✦ Advisory definition. ✦ Precautions and a call-to-action statement.
Excessive Heat Warning	___NPW___	Local NWS Office	An Excessive Heat Warning is issued when conditions are considered dangerous. The warning includes the: ✦ Area affected. ✦ Potential temperatures, heat index, general impacts, and general conditions. ✦ Timing of events, including the beginning, peak, and ending. ✦ Reasons for the warning. ✦ Advisory definition. ✦ Precautions and a call-to-action statement.
Discussions N/A			
Short Term Forecasts	___NOW___	Local NWS Office	The NOW forecast is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings, and advisories in effect at the time.

DUSTSTORMS

DEFINITION

Strong winds over dry ground that has little or no vegetation can lift particles of dust or sand into the air. These airborne particles can reduce visibility, cause respiratory problems, and have an abrasive affect on machinery. A concentration reducing the visibility to ¼ mile or less often poses hazards for travelers.

CHARACTERISTICS

Duststorms cause a significant reduction in visibility (to ¼ mile or less), cause damage and injury, and affect commerce.

There are two situations that lead to the development of blowing dust or sand:

- ✦ Sustained high wind at the surface, which tends to pick up dust and sand in dry environments. This condition may last for several hours or even days and may occur simultaneously with a windstorm. (Refer to the fact sheet on windstorms for more information.) This is referred to as a nonconvective event.
- ✦ Local events because of thunderstorm outflow or micro bursts. In this situation, the event is usually sudden and short, over in a matter of minutes. These events are referred to as convective events.

Factors affecting both nonconvective and convective events are shown in the table on the next page.

FACTOR	*LARGE-SCALE, NONCONVECTIVE EVENTS*	*CONVECTIVE EVENTS*
Speed of onset	Recognizable weather patterns are easily identified 24 to 36 hours in advance.	✦ Predictable over an area of jurisdiction within 0 to 3 hours. ✦ Specific locations identifiable only minutes in advance.
Duration	Ranges from 3 to 4 hours up to 2 to 3 days, usually with nocturnal lulls.	✦ Micro bursts—a few seconds. ✦ Macro bursts—a few minutes. ✦ Wake depression—up to two hours.
Timing	✦ Occur mainly during the late winter and early spring when pressure gradients are extreme. ✦ Conditions worsen during late morning and are most intense during late afternoon.	Occur in association with late afternoon or evening thunderstorms, usually during the spring and summer.

CHARACTERISTICS

Duststorms involve horizontal high winds or wind gusts and blowing dust, sand, or both. The hazards and damage caused by these storms include:

- Impaired visibility and breathing difficulties, especially for outdoor workers, people in recreational activities, and motorists.
- Crop damage.
- Destruction to buildings, vehicles, and trailers.
- Power outages and other infrastructure damage.
- Broken trees.
- Scouring damage to buildings and automobiles.
- Damage to computers and communications equipment from accumulated dust.

High winds may accompany major winter or early spring blizzards. A mixture of snow and dust may bring travel to a standstill. For convective duststorms, all elements associated with severe thunderstorms may occur. Refer to the fact sheet on thunderstorms for more information.

HISTORICAL EXAMPLES

- In April 1995, a duststorm caused a 24-car wreck in Arizona that killed 10 people. Swirling dust reduced visibility to less than a car length.
- In March 1975, a mixture of blowing dust and sand accompanied high winds (at times exceeding 100 m.p.h.) in the Texas South Plains. Visibility remained near zero during daylight hours for 3 days. Dust extended aloft to 30,000 feet, and visibility was reduced as far east as Atlanta. A total of 1.38 inches of dust collected in an official rain gauge at the Lubbock, Texas Weather Service Forecast Office. Commerce came to a standstill, with most highways closed due to overturned tractor trailers, blowing tumbleweeds, and the sandblasting effect on automobiles.

PRODUCTS

The following table lists NWS products that provide planning and preparedness information on duststorms. Refer to the fact sheet on windstorms for other products.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Blowing Dust or Sand	___SPS___	Local NWS Office	This product is issued when there is a good chance of blowing dust or sand occurring. The prime goal of the outlook is to give advance notice. An outlook includes the: ✦ Area of impact. ✦ Hazards. ✦ Timeframes.
Watches Blowing Dust/Sand Watch	___NPW___	Local NWS Office	A watch is issued when conditions are favorable for blowing dust or sand to develop. It is issued 12-24 hours in advance. A watch includes the: ✦ Area affected. ✦ Reason for the watch. ✦ Potential impact. ✦ Explanation of the watch and uncertainty. ✦ Precautions and a call-to-action statement.
Statements	___SPS___	Local NWS Office	Special Weather Statements are issued to cancel Non-Precipitation Watches.
Advisories Blowing Dust/Sand	___NPW___	Local NWS Office	A blowing dust/sand advisory should be issued when existing or imminent significant events cover part or all of the area and pose a mere inconvenience. An advisory includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of the event's beginning, ending, peaking, and weakening. ✦ Advisory definition. ✦ Precautions and calls to action.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Warnings Blowing Dust/Sand Warning	___NPW___	Local NWS Office	A Blowing Dust/Sand Warning should be issued when existing or imminent significant blowing dust/sand covers part or all of the forecast area and is a threat to safety and property. A warning includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of the event's beginning, ending, peaking, and weakening. ✦ Advisory definition. ✦ Precautions and call to action.
Discussions N/A			
Short Term Forecasts	___NOW___	Local NWS Office	The NOW forecast is intended as the primary way to provide a short term forecast of hydrometeorological conditions over an area. It gives a concise forecast of the most significant weather during the next few hours. It highlights watches, warnings and advisories in effect at the time.

WINDSTORMS

DEFINITION

High winds not associated with convective events (severe local storms, hurricanes, and winter storms) require a warning when one of the following occurs:

- Sustained wind speeds of 40 m.p.h. or greater lasting for 1 hour or longer.
- Winds of 58 m.p.h. or greater for any duration.

The above thresholds generally are increased for locations at higher elevations because of the lower air density and subsequent reduction in damage from less force.

The types of wind that do not involve the mechanism of convection include:

- **Gradient High Winds.** High winds that usually cover a large area and are due to large-scale pressure systems.
- **Mesoscale High Winds.** These high winds usually follow the passage of organized convective systems and are associated with wake depressions or strong meso-scale (small-scale) high pressure.
- **Channeled High Winds.** In mountainous areas or in cities with tall buildings, air can be channeled through constricted passages producing high winds. Channeled high winds are local in nature but can be extremely strong.
- **Tropical Cyclone-Associated High Winds.** High winds can occur a few hundred miles from the coast of a landfalling tropical cyclone. These inland winds are forecasted independent of the tropical cyclone.
- **Chinook or Foehn Wind.** These are warm, dry winds that occur in the lee of high mountains ranges. They are fairly common in the mountainous West and sections of Alaska during the winter months. These winds develop in well defined areas and can be quite strong.

CHARACTERISTICS

Windstorms are caused by an extreme pressure gradient (difference in pressure over a small distance). The pressure gradient itself may be caused by one or more factors:

- Terrain effect.
- Temperature differences, as with downslope winds.
- Mesoscale systems or convective complexes.

CHARACTERISTICS

Windstorms involve sustained, potentially damaging, high winds. These high winds can cause the following hazards and damage:

- ✦ Impaired visibility.
- ✦ Crop damage.
- ✦ Destruction to buildings and vehicles.
- ✦ Power outages and other infrastructure damage.
- ✦ Broken trees.

High winds may accompany major winter or early spring blizzards. Major high-wind events frequently affect multiple jurisdictions, extending horizontally for hundreds of miles.

Windstorms are nonconvective events, and the speed of onset is less than with convective events, such as duststorms. Recognizable weather patterns are easily identified 24 to 36 hours in advance of a large scale, nonconvective storm. The NWS may issue a High Wind Watch during this period.

The duration of the event ranges from about 4 hours up to 2 to 3 days, usually with nocturnal lulls. The storms occur mainly during the late winter and early spring, when pressure gradients are extreme and soils are bare. They worsen during the late morning and become most intense during the late afternoon, when atmospheric mixing is most pronounced.

HISTORICAL EXAMPLE

A wind and duststorm along a California highway in November 1991 caused a wreck leaving 17 dead and 150 injured. This storm came during the sixth year of a drought.

PRODUCTS

The following table lists NWS products that can provide planning and preparedness information on windstorms. Refer to the fact sheet on duststorms for more information.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Potential for High Winds	___SPS___	Local NWS Office	This product is issued when there is a good chance of high winds occurring. The timeframe is 12+ hours. The primary goal of the outlook is to give advance notice. An outlook includes the: ✦ Inherent uncertainty of the event. ✦ Area of impact. ✦ Hazards. ✦ Timeframes.
Watches High Wind Watch	___NPW___	Local NWS Office	A watch is issued when conditions are favorable for high winds to develop. It comes 12-24 hours in advance. A watch includes the: ✦ Area affected. ✦ Reason for the watch. ✦ Potential impact. ✦ Explanation of the watch and uncertainty. ✦ Precautions and calls to action.
Statements	___SPS___	Local NWS Office	Special Weather Statements are issued to cancel Non-Precipitation Watches.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories High Wind Advisory	___NPW___	Local NWS Office	A High Wind Advisory should be issued when existing or imminent high winds cover part or all of the area and pose a mere inconvenience. An advisory includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of events, including the beginning, ending, peaking, and weakening. ✦ Reasons for the advisory. ✦ Advisory definition. ✦ Precautions and calls to action.
Warnings High Wind Warning	___NPW___	Local NWS Office	A High Wind Warning should be issued when existing or imminent high winds cover part or all of the forecast area and pose a threat to life and property. A warning includes the: ✦ Area and time affected. ✦ Potential impact. ✦ Timing of events, including the beginning, ending, peaking, and weakening. ✦ Reasons for the warning. ✦ Warning definition. ✦ Precautions and calls to action.
Discussions N/A			
Short Term Forecasts	___NOW___	Local NWS Office	These forecasts are intended as the primary way to provide short term forecasts of hydrometeorological conditions over an area. They give a concise forecast of the most significant weather during the next few hours. They highlight watches, warnings, and advisories in effect at the time.

FIRE WEATHER

DEFINITIONS

Fire weather is a term used for the meteorological conditions that promote the spread of wildfire. Hydrological and topographical and vegetation conditions also impact the spread of fire.

Fire Weather Offices are those Weather Service Forecast Offices (WSFO) and Weather Service Offices (WSO) assigned responsibility to provide fire weather services for specified areas.

Fire Danger is the result of both constant factors (fuels) and variable factors (primarily weather) that affect the ignition, spread, and difficulty of control of fires and the damage they cause.

Prescribed Burn is fire applied to wildland fuels, in a definite place for a specific purpose under exacting weather and fuel conditions (the prescription), to achieve land management objectives.

Wildfire is any free-burning and uncontainable wildland fire not prescribed for the area that consumes the natural fuels and spreads in response to its environment.

Wildlands are any non-urbanized land not under extensive agricultural cultivation (e.g., forests, grasslands, rangelands).

CHARACTERISTICS

The following weather conditions promote ignition and rapid spread of fires:

- ✦ Low humidity.
- ✦ High winds (over 10–20 m.p.h.).
- ✦ Dry thunderstorm (i.e., lightning without rain).
- ✦ Unstable air.

Other factors that impact the spread and severity of fires include:

- ✦ **Dry, antecedent conditions**. Prolonged hot, dry conditions greatly increase fire danger. In drought conditions, forests can ignite with a weak source that would normally not be a threat.
- ✦ **Urban-wildland interface**. The spread and severity of residential areas into wildlands means the population faces a greater risk of forest fires. Coordination is necessary between urban emergency responders and land management agencies, such as the USDA Forest Service, the National Park Service, Bureau of Indian Affairs, and the Bureau of Land Management.
- ✦ **Available fuel**. The spread of fire depends on the amount of burnable material. Trees that contain oily sap, such as eucalyptus, provide tremendous fuel when dry.
- ✦ **Hilly terrain**. When other factors are even, fire spreads faster uphill than downhill.

CHARACTERISTICS

Forecasters use the **Haines Index** to indicate the potential for large fire growth. The Haines Index is shown below.

HAINES INDEX	*RISK*
2 or 3	Very low
4	Low
5	Moderate
6	High

HISTORICAL EXAMPLE

In October 1991, brush fires swept through the Oakland, California suburbs, which abutted a grassland area. Many analysts attributed the extensive damage to the century-old practice of planting eucalyptus trees in the area. Eucalyptus trees are oily and volatile, creating a serious fire hazard. Strong winds and extended drought contributed to the rapid spread of this fire. Preliminary estimates put damages between $2.5 and $5 billion. Twenty-three people died and 148 were injured.

SOURCES OF INFORMATION

The U.S. Forest Service manages fire fighting activities on National Forest land, though interagency cooperation is the rule in wildland fire fighting. Other Federal agencies that may be involved with fire management on Federal land include the:

- ✦ Bureau of Land Management.
- ✦ National Park Service.
- ✦ Bureau of Indian Affairs.
- ✦ Fish and Wildlife Service.
- ✦ Bureau of Reclamation.
- ✦ Department of Defense.

PRODUCTS

The following table lists NWS products that provide planning and preparedness information on fire weather conditions.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks Outlook and Extended Forecast	____FWF___	Local Weather Service Fire Weather Office (FWO)	This forecast is issued as part of the routine Fire Weather Forecast to cover 2 or 3 days beyond the basic forecast period. General terms are used to highlight weather elements critical to the user agency's operation. Longer range outlooks also may be issued on request for advance planning by fire managers.
Watches Fire Weather Watch	___FWF___	Local Weather Service Office FWO	This product is used to advise of the possible development of a red flag event in the near future. It is issued by a fire weather forecaster for all or any portion of his or her area of responsibility when he or she is reasonably confident that a red flag event will occur. It should be issued 12 to 48 hours in advance but not more than 72 hours in advance of the expected onset of critical weather conditions. It remains in effect until the: ✦ Forecaster determines that the event will not occur and the watch will be canceled; or ✦ Watch is upgraded to a red flag warning.
Statements Rangeland and Fire Danger Statement	___RFD___	Local Weather Service Office FWO	This product describes weather conditions as they relate to fire danger in rangeland.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings Red Flag Warning	___RFW___ ___FWF___	Local Weather Service Office FWO	This is used to warn of an impending or actual occurrence of a red flag event. It is issued by the fire weather forecaster for any portion of or all of his or her area of responsibility. The warning remains in effect until critical weather conditions cease or fail to develop as forecast. The warning includes a brief description of the conditions causing the ongoing or forecast event. A Red Flag Warning is issued solely for the purpose of advising land management agencies of critical fire weather conditions. It should not be confused with other agencies' red flag alert programs.
Discussions	___FWF___	Local Weather Service Office FWO	A discussion of relevant weather patterns is included as part of every presuppression or land management forecast.
Short Term Forecasts Spot Forecast For Wildfires and Prescribed Burning	___FWF___	Local Weather Service Office FWO	This forecast is a site-specific, localized forecast of weather including a detailed 12-hour forecast and an additional 12-hour outlook of the: ✦ Winds (including the time of wind shifts due to terrain effects). ✦ Maximum and minimum temperature. ✦ Maximum and minimum humidity. A Spot Forecast initially is issued only upon request. Additional forecasts or revisions are issued as necessary.

OTHER HAZARDS

INTRODUCTION

In addition to weather-related disasters, communities may also face geologic disasters (such as earthquakes and related tsunamis) and manmade catastrophes (such as terrorist events). Although all types of disasters pose similar challenges to the community, terrorist threats especially create unique problems for emergency management professionals and the population at large. This section includes a comparison of natural disasters and incidents involving weapons on mass destruction (WMD).

This section describes the characteristics of earthquakes; tsunamis; and nuclear, biological, and chemical agents used in weapons of mass destruction. Historical examples of each type of disaster are listed. For tsunamis, NWS products that can provide planning and preparedness information are described. For biological and chemical agents, tables list symptoms, incubation periods, and mortality rates.

Refer to this section when you need to know the dangers that these events potentially pose to your community.

EARTHQUAKES

DEFINITION

An earthquake is defined as the shaking of the Earth's surface, sometimes violently, following a release of energy in the Earth's crust.

CHARACTERISTICS

Over the last 25 years, scientists have concluded that the Earth is a patchwork of plates that move relative to one another, spreading apart and colliding with each other as they slowly move on top of the Earth's pliable, hot interior layers.

About 90 percent of earthquakes occur at plate boundaries. There are three types of plate boundaries:

- *Spreading zones* are areas in which molten rock is rising and pushing two plates apart. Most spreading zones are in the ocean.
- *Transform faults* occur where plates slide past one another.
- *Subduction zones* are found where one plate overrides or "subducts" another, pushing it downward into the Earth's hot mantle.

It is important to learn the basic terms used in describing earthquakes.

- The *focus* is the region where the release of energy originates.
- The *focal depth* is the distance from the focus to the surface.
- The *epicenter* is the point on the Earth's surface directly above the focus. Geologists identify earthquake location by referring to the epicenter.

To understand how earthquakes are detected, recorded, and measured, you must understand the different categories of vibrations that occur when energy is released.

- *Surface waves* travel along the Earth's surface. They have the strongest vibration and probably cause most of the damage that results from earthquakes.
- *Body waves* pass through the Earth's interior to distant points on the surface. Types of body waves include *compression waves* and *shear waves*.
- *Compression waves* travel at great speeds and ordinarily reach the surface first, so they are called *primary or P-waves*.
- *Shear waves* travel more slowly, so they are called *secondary or S-waves*.

CHARACTERISTICS

The first indication of an earthquake is a sharp thrust, indicating the compression wave has arrived. Then the shear waves arrive and the surface waves cause a "ground roll."

Scientists use a *seismograph* to record the changing intensity of these vibrations. They can use the data thus obtained to determine the time, epicenter, and focal depth of an earthquake, as well as the type of faulting that occurred and how much energy was released by the quake. Keeping this type of history of quake activity is important in predicting future events.

Scientists compare the severity of earthquakes using two different types of measurements:

- The number we hear quoted most frequently is the *Richter Scale* number, which is a measure of the amplitude of seismic waves. The scale is logarithmic, which means that an earthquake that measures 7 on the Richter Scale has ground motion 10 times as large as one with a measurement of 6. Earthquakes of 6 or more are major. Extremely strong earthquakes have magnitudes of 8 or more.
- The *Modified Mercalli Scale* is a subjective measure of strength of shock that gives specific descriptions for each of 12 gradations. For example, a level 1 is "not felt except by a very few under especially favorable conditions," while a level 12 means, "damage total. Lines of sight and level are distorted. Objects thrown upward into the air." This scale is used based on eyewitness reports and field investigations. On the Modified Mercalli Scale, the Alaska earthquake of 1964 was a 10.

Scientists also measure the amount of energy released, a figure that can be derived from seismograph records.

An earthquake's severity is not the only measurement of its destructiveness. Factors in destructiveness include:

- The **geologic conditions** in the area. If the area is underlain by sand, clay, or other relatively loose and unconsolidated material, the effects would be more noticeable because the ground is less stable.
- The **focal depth and distance from the epicenter** will be important, because earthquake effects diminish with distance.
- The **design of buildings** and other structures will make a significant difference. Protective building strategies (i.e., earthquake engineering) play a major role in mitigating the damage from earthquakes.
- Finally, the more people and property that are at risk in the area, the higher losses could climb.

HISTORICAL EXAMPLES

- The New Madrid earthquakes of 1811–1812, which occurred in a fault zone along the Mississippi River, were the most widely felt earthquakes in the recorded history of North America. Aftershocks were felt as far away as Boston. The area was sparsely populated, however, so damage was relatively slight. The same earthquake today would affect millions of people and cost billions of dollars.
- The San Francisco earthquake of 1906, by contrast, was a much weaker earthquake than New Madrid, but the quake killed nearly 800 people and left the city in ruins. Much of the damage occurred in the major fire that followed the quake, which left 250,000 people homeless.

TSUNAMIS

DEFINITION

A tsunami is a series of ocean waves of extremely long length, generated by disturbances from earthquakes, underwater volcanic eruptions, or landslides occurring below or near the ocean floor.

CHARACTERISTICS

From wave crest to wave crest, the length of a tsunami may be 100 miles or more in the deep ocean, with a wave height of only a few feet or less. The waves may reach speeds of up to 500 m.p.h. As tsunamis approach land and the water depth decreases, wave heights may increase to between 30 and 100 feet. Tsunamis from nearby earthquakes may take only a few minutes to reach coastal areas, but may take up to 24 hours from distant earthquakes.

The deep ocean trenches off the coasts of the Aleutian Islands, Japan, and South America are known for their underwater earthquakes and are the source for many tsunamis.

Hazards from tsunamis include coastal flooding and damage from debris. The flood inundation area from a tsunami may be extensive, as tsunamis can travel up rivers and streams that lead to the ocean. Defining the extent of worst-case flooding is an important aspect of preparing for tsunamis.

HISTORICAL EXAMPLES

- A tsunami in Nicaragua in 1992 was generated from movement occurring beneath the ocean floor. This "slow" earthquake generated a devastating tsunami with localized damage to coastal communities in Nicaragua.
- In March 1964, a tsunami hit Alaska following an earthquake in the sea floor beneath Prince William Sound. The tsunami hit the coast between 20 and 30 minutes after the quake, devastating villages. Damages were estimated to be over $100 million. Approximately 120 people drowned.
- A 1960 Chilean earthquake generated a Pacific-wide tsunami that caused widespread death and destruction in Chile, Hawaii, Japan, and other areas in the Pacific.

PRODUCTS

The International Tsunami Information Center (ITIC), run jointly by the NWS and the Intergovernmental Oceanographic Commission, is the primary source for non-operational tsunami information.

The purpose of the ITIC is to**:**

- ✦ Locate and size major earthquakes in the Pacific Basin.
- ✦ Determine their potential for generating tsunamis.
- ✦ Predict tsunami wave arrival times and, when possible, runup on the coast.
- ✦ Provide timely and effective tsunami information and warnings to the population of the Pacific to reduce the hazards of tsunamis, especially to human life.

NWS operates two tsunami warning centers: the **Alaska Tsunami Warning Center** (ATWC) and the **Pacific Tsunami Warning Center** (PTWC) in Hawaii.

The PTWC carries the responsibility for regional, national and international warning services while the ATWC has only regional responsibility.

Area of Responsibility (AOR)—the geographical area within which a center has the responsibility for the dissemination of tsunami watches, warnings, and information bulletins and the provision of interpretive information to emergency managers and other officials.

- ✦ The **ATWC,** located in Palmer, Alaska, is the regional center for:
  - ✧ Alaska.
  - ✧ British Columbia.
  - ✧ Washington.
  - ✧ Oregon.
  - ✧ California.
- ✦ The **PTWC,** located at Ewa Beach, Oahu, Hawaii, is:
  - ✧ The regional center for Hawaii.
  - ✧ The national center for the United States.
  - ✧ The international center for the Pacific.

Regional Tsunami Warning Center—a center that is responsible for the detection of tsunamis in the ocean basin that pose a threat within its regional AOR.

PRODUCTS

National Tsunami Warning Center—a center that is responsible for the detection of tsunamis in the ocean basin that pose a threat to U.S. National interests outside of a regional AOR.

The International Warning System provides watch/warning services to all of the nations of the Pacific who are members of the International Coordination Group for the TWS in the Pacific (ICG/ITSU) or those who provide the Tsunami Warning Service with supporting data.

The table below and on the following pages lists NWS products that can provide planning and preparedness information on tsunamis.

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Outlooks N/A			
Watches Regional Tsunami Watch	ANCTSUPAQ (Alaska) HNLTSUCP (Pacific)	Alaska and Pacific Tsunami Warning Centers	This product is a bulletin issued initially using only seismic information to alert all within one to three hours travel time beyond the tsunami warning area. The watch is expanded hourly until it is canceled or upgraded by issuing a Pacific-wide Warning. A watch may be included in the text of the message that disseminates a Regional Tsunami Warning.
Statements N/A			

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings			
Regional Tsunami Warning	ANCTSUPAQ (Alaska) HNLTSUCP (Pacific)	Alaska (ATWC) and Pacific (PTWC) Tsunami Warning Centers	This bulletin usually is based only on seismic information without tsunami confirmation and is issued as a means of providing the earliest possible alert to the population near the epicentral area of an earthquake. It places the restricted area (2- to 3-hour tsunami travel time) in a condition that requires all coastal areas in the region to be prepared for imminent flooding from a tsunami. Subsequent warning bulletins that incrementally expand the warning area are issued at least hourly or when conditions warrant until the warning is either upgraded to a Pacific-wide Warning or canceled.
Pacific-wide Tsunami Warning	HNLTSUCP	PTWC	This warning is issued by the PTWC after confirmation has been received that a tsunami has been generated that has caused damage at distances greater than 1000 km from the epicenter and thus poses a threat to any populated area within the Pacific Basin that is located within the PTWC's area of responsibility.
Tsunami Advisory	ANCTSUPAQ	ATWC	This bulletin is issued to advise interested persons within its area of responsibility that the Pacific Tsunami Warning Center has issued a tsunami warning for an earthquake whose epicenter is located outside of the Alaska Tsunami Warning Center Area of Responsibility (AOR) and more than six hours tsunami travel time from any part of the ATWC AOR, and that ATWC will continue to monitor the event, issuing hourly updates. The advisory will be continued, upgraded to a watch or warning, or canceled.

PRODUCTS

PRODUCT	*IDENTIFIER*	*SOURCE*	*DESCRIPTION*
Advisories/ Warnings (Continued) Tsunami Information Bulletin	ANCTSUPAQ HNLTSUCP	ATWC PTWC	This product is issued by both the ATWC and the PTWC to advise participants of the occurrence of an earthquake in the Pacific or near-Pacific area with the evaluation that a potentially destructive tsunami was not generated. If the evaluation indicated the possible generation of a non-destructive tsunami, an investigation is initiated and additional tsunami information bulletins are issued until the investigation is concluded.
Discussions N/A			
Short Term Forecasts N/A			

TERRORIST THREATS

DEFINITION

As used in Presidential Decision Directive 39 (PDD-39), terrorism involving weapons of mass destruction refers to "nuclear, biological, or chemical (NBC) materials or weapons used by terrorists."

CHARACTERISTICS

- The Department of Defense (DoD) estimates that as many as 26 nations may possess chemical agents and/or weapons, and an additional 12 may be seeking to develop them.
- The Central Intelligence Agency (CIA) reports that at least 10 countries are believed to possess or be conducting research on biological agents.
- In recent years, the largest number of terrorist incidents within the United States has occurred in the Western United States and Puerto Rico. Attacks in Puerto Rico accounted for about 60 percent of all terrorist incidents that occurred on United States territory between 1983 and 1991.
- In the United States, most terrorist incidents have involved small extremist groups who use terrorism to achieve a designated objective. Local, State, and Federal law enforcement officials monitor suspected terrorist groups to try to prevent or protect against a suspected attack.
- A terrorist attack can take several forms, depending on the technological means available to the terrorists, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Bombings are the most frequently used terrorist method in the United States.
- Most local emergency management systems need enhanced capabilities to manage the threat or use of Weapons of Mass Destruction (WMD). Issues that may be commonly encountered include:

  - Difficulty in identifying the agent.
  - Determining the most appropriate means of protection.
  - Decontaminating and treating (victims, incident sites, and the environment).
  - Identifying and providing appropriate treatment (initial and definitive).
  - Identifying and providing diverse collateral requirements (public safety, mental health, etc.).
  - Determining the appropriate disposition of the deceased.

- There may be no advance warning of a chemical or biological attack. The first indication of an attack may be when people begin to exhibit advanced symptoms.
- Chemical and biological agents usually move through the air. Ventilation systems in buildings or transportation facilities may help to speed dissemination by carrying the agent far from its initial source.
- Many chemical agents pose an immediate threat to life. Antidotes are available for some, but not all, chemical agents, but must be used within minutes of exposure. In many cases, additional extensive medical emergency treatment is required, especially resuscitation.

CHARACTERISTICS

- ✦ Once disseminated, chemical agents require decontamination, tying up resources and increasing media attention.
- ✦ Some incidents may appear initially to be more routine HazMat incidents, and only later found to be terrorist incidents. At that point, the situation will change, and the incident site will be designated a crime scene.
- ✦ Local first responders may not be trained in responding to biological or chemical WMD and will not always have the appropriate protective equipment. Because of lack of knowledge and awareness in treating such events, first responders may become victims themselves.
- ✦ The number of potential casualties and the extent of the areas involved can quickly overwhelm local capabilities.
- ✦ There is an increased concern about how to deal with the threats posed by weapons of mass destruction. A WMD incident challenges the confidence of emergency response personnel and the capacity of the health care system.
- ✦ Most local emergency systems require an enhanced capability system to manage a WMD threat. They require a capability for agent identification, personal protection, decontamination, and effective initial and definitive methods of treatment.
- ✦ Health systems for response to WMD incidents require the capability for: agent identification, safe extraction, and antidote administration; victim decontamination, triage, and primary care; emergency medical transportation; local and regional definitive medial care; forward movement of victims for additional care; and appropriate disposition of the deceased. Health systems personnel must also ensure decontamination of the incident site to safe levels.
- ✦ The political pressure surrounding a WMD event can be intense. Public officials will experience anger and frustration from the public's feelings of helplessness.
- ✦ Local officials must plan for the unexpected. Key personnel may be out of town or unable to handle the pressure. Other factors, such as adverse weather, may delay the arrival of assistance from outside sources.
- ✦ The public is likely to panic because of its unfamiliarity with the event. It is important to have accurate health-related information available.
- ✦ Rapid response is required to save lives. During chemical incidents, immediate response and appropriate action within the first 30 to 90 minutes is crucial.

These points provide the context for the Nunn-Lugar-Domenici legislation and its resulting training, the formation of Metropolitan Medical Strike Teams, and the provision of NBC equipment from the Department of Defense.

HISTORICAL EXAMPLES

WMD events—and threats of WMD events—have increased dramatically since 1970, rising from a single incident in the 1970s to three in the 1980s, to an exponential increase in the 1990s. Descriptions of some of these incidents and potential incidents are listed below.

- In 1972, members of a U.S. Fascist group called Order of the Rising Sun were found to be in possession of 30-40 kilograms of typhoid bacteria cultures, with which they planned to contaminate water supplies in Chicago, St. Louis, and other Midwestern cities.
- In 1984, two members of an Oregon cult headed by Bhagwan Shree Rajneesh cultivated salmonella (food poisoning) bacteria and used them to contaminate restaurant salad bars in an attempt to affect the outcome of a local election. Although some 751 people became ill and 45 were hospitalized, there were no fatalities.
- The World Trade Center is the second largest building in the world and houses 100,000 workers and visitors each day. On February 29, 1993, a bombing in the parking garage of the World Trade Center in New York City resulted in the deaths of five people and injuries to thousands. The bomb left a crater 200 by 100 feet wide and five stories deep.
- In March 1995, four members of the Minnesota Patriots Council, a right-wing militia organization advocating violent overthrow of the U.S. government, were convicted of conspiracy charges under the Biological Weapons Antiterrorism Act for planning to use ricin, a lethal biological toxin. The four men—Douglas Baker, Richard Oelrich, Dennis Henderson, and Leroy Wheeler—allegedly conspired to assassinate federal agents who had served papers on one of them for tax violation.
- In May 1995, Larry Wayne Harris, a member of the neo-Nazi organization Aryan Nations, was arrested in Ohio on charges of mail fraud and fraud by wire after allegedly misrepresenting himself when ordering three vials of freeze-dried yersinia pestis, the bacteria which causes bubonic plague, from a Maryland biological laboratory.
- In December 1995, Thomas Lewis Lavy from Arkansas was charged with possession of the toxin ricin in violation of the Biological Weapons Antiterrorism Act of 1989. In 1993, Canadian customs officials had intercepted a stack of currency with a white powder interspersed between the bills. Suspecting cocaine, customs had the material analyzed, and discovered that it was not cocaine but ricin. Lavy was arrested and the next day hanged himself in his jail cell.
- In the Centennial Olympic Park-Olympic Games bombing in Atlanta, Georgia, on July 27, 1996, there were two deaths and 110 injuries.
- In April 1997, Russian police arrested a group which tried to sell 11 pounds of uranium-235 stolen from a production plant in Kazakstan. It takes several pounds of enriched uranium to make a nuclear weapon.

COMPARISON OF WMD AND NATURAL DISASTERS

A brief comparison of the characteristics of WMD incidents with those of natural disasters. By drawing on the similarities between WMD and non-WMD incidents, local officials can focus on these aspects that are different—the "NBC Delta."

SIMILARITIES	*DIFFERENCES*
✦ May occur without warning. ✦ May involve mass casualties. ✦ May included property damage.	✦ Will always be a crime scene. A WMD incident is a deliberate attack designed to maim and kill. ✦ May not be immediately recognizable. Many chemical and biological agents promote symptoms that are similar to other types of illnesses. ✦ May not be a single event. There may be multiple incident sites with a WMD event. ✦ Place responders at higher risk. Secondary devices may target first responders. ✦ May expand geometrically. NBC agents are far more toxic than the hazardous materials typically found at a HazMat incident. ✦ Will instill public panic.

NUCLEAR TERRORISM

Few ideas instill as much fear as the thought of nuclear capability in the wrong hands. Since the end of the Cold War, there has been an increase in the amount of radioactive material available and a growing variety of ways in which terrorists can access radioactive substances. The amount of weapons-grade fuel that remains from the dismantling of the former Soviet nuclear forces alone is estimated to be in excess of 10,000 kilograms (kgs) of plutonium and 500,000 kgs of weapons-grade uranium. During the next five years, nuclear power plants are expected to produce 110 metric tons of plutonium, and by the year 2000, there will be twice as much plutonium in civilian sectors as that possessed by the military. This material can be bought on the black market, stolen, hijacked in transit, or acquired by bribing disgruntled employees in the military or scientific communities.

While little probability exists that a terrorist organization would be capable of producing a nuclear warhead, the alternative is simply to construct an explosive device that disperses radioactive materials. To date, there have been a few cases of radioactive dispersal attacks, including incidents in both Austria and France, and in the State of Texas.

The most feasible, and therefore most likely, form of nuclear terrorism is a direct assault on a nuclear facility, such as a power station. Considering the amount of radiation housed at such a facility, the magnitude of a single attack of this kind could exceed more than 100,000 deaths and the ruin of the surrounding land for decades.

PENETRATION

An attack on a nuclear plant could result from penetration of the facility. For example, on February 7, 1993, an intruder was discovered to have penetrated the Three Mile Island Nuclear Generating Station near Harrisburg, Pennsylvania. The intruder, a 31-year-old man who suffered from depression, drove into the guarded entrance, crashed his car through a fence and a roll-up door, and proceeded 63 feet inside of a turbine building. The plant continued to operate at full power while the staff monitored gauges and alarms. All access doors were locked by computer control, yet the Nuclear Regulatory Commission (NRC) knew that this measure would delay an intruder armed with a satchel charge by only 15 seconds. This intruder was arrested four hours later. The NRC's Incident Investigation Team (IIT) found more than 40 problems with the response of the staff, and concluded, ". . . the strategies used . . . would not have precluded an individual . . . from reaching and attempting to enter the vital area before being interdicted by armed responders."

Other attempts at penetration of nuclear facilities have included:

- North Korea. Four North Korean commandos were killed by a South Korean naval patrol when they attempted to come ashore near a nuclear power plant.
- South Africa. At the Koeberg plant near Cape Town, guerillas penetrated the heavily guarded plant and damaged the control room.
- France. Attackers launched rocket-propelled grenades and anti-tank missiles at the Super Phoenix plant.

SABOTAGE

Nuclear plants can be threatened also by sabotage. Some examples of this type of threat have occurred in:

- Virginia. Control room operators at the Surry plant poured sodium hydroxide onto new fuel assemblies.
- New Jersey. Someone intentionally tripped a steam generator feedwater pump. This event imitated the Three Mile Island trip that had led to a serious accident at that plant.
- Pennsylvania. A major portion of the emergency core cooling system was disabled at the Beaver Valley nuclear plant.
- New York. Someone sabotaged the emergency diesel generators at the Nine Mile Point Reactor.
- Idaho. A worker intentionally caused a damaging condition known as a "power excursion" by withdrawing a control rod too far. The resulting steam explosion destroyed the reactor, killing the saboteur and two other workers. The event was classified a murder/suicide.
- Texas. Central alarm station wires were cut at the South Texas plant by an employee who was about to be laid off.
- Illinois. A firewatch employee at the Braidwood facility vandalized wires and fireproofing.
- Florida. An employee suspected of being disgruntled because of alleged cost-cutting measures poured glue into three lockable switches on the backup control panel at Florida Power and Light Company's St. Lucie nuclear power pant.

TRUCK BOMBS

Shortly after the bombing of the U.S. marine barracks in Beirut (1984), the NRC commissioned "An Analysis of Truck Bomb Threats at Nuclear Facilities," which was performed by the Sandia National Laboratories. One of the results of the analysis was that, at some plants, a large bomb that is detonated offsite could cause enough damage to lead to a deadly release of radiation or even a meltdown. Some plants, however, are too small to erect barriers with proper setback distances to preclude this kind of attack.

LOST AND STOLEN NUCLEAR MATERIALS

Radioactive sources are lost, stolen, mistakenly shipped, or illegally discarded regularly in the United States. The potential exists for some of these sources to be intentionally placed to cause harm.

LOST AND STOLEN NUCLEAR MATERIALS

Cases of lost, stolen, mistakenly shipped, or illegally discarded radiation sources occurred in:

- Ohio. Cesium-137 was found in the trunk of a crushed car at a scrapyard in Cincinnati.
- Pennsylvania. 33,000 shovel blades were made of steel contaminated with radioactive thorium near Harrisburg.
- Indiana. Radioactive iodine was found in diapers at a garbage dump in Indianapolis.
- Pennsylvania. A plutonium pacemaker was reported missing by a hospital near Philadelphia.
- Minnesota. A hospital in Minneapolis received three radioactive-contaminated packages from the same corporation within two months.
- Arizona. Five men were videotaped stealing radioactive tritium from a glow-in-the-dark exit sign at Arizona State University.
- Unknown location. A huge source-term of radioactive iridium was reported lost in shipment by a private courier.
- California. A package of radioactive Xenon was lost when it fell out of an unsecured back door of a private delivery service's van in Sacramento.
- Michigan and Massachusetts. Packages of radioactive thallium fell from the vehicles of a private delivery service and were struck by cars, releasing their contents.
- Virginia. A Russian-produced fuel assembly with 12 fuel rods containing 2% enriched uranium was unaccounted for by a U.S. crew in Lynchburg.

COMMUNITY IMPACT

A nuclear terrorist strike on a community would have multiple impacts. A successful attack, whether by penetration, sabotage, or truck bomb, on a facility such as a nuclear power plant would cause widespread destruction and render the area uninhabitable for the foreseeable future.

Given warning, evacuation of a population within the threatened radius would require a massive effort, considering that schools, hospitals, nursing homes, and prisons could be affected. Transportation and shelter requirements could place a tremendous strain on both the endangered community and those that surround it. Provisions for medical treatment and handling of contaminated material and human remains would tax personnel and facilities. The spread of panic through rumors and misinformation could hinder an effective response.

The structural damage that could result from an explosion intended to release radioactive material could pose additional danger. A bomb on a rail car, in a subway, or at an airport would close those routes of transportation for an extended period of time. Bridges, overpasses, and tunnels could not only be contaminated but could be incapacitated as means of ingress and egress.

Long-term health effects from the exposure to radiation would be a consideration, and long-term cleanup efforts would be costly.

PREPAREDNESS THROUGH PLANNING

Because a nuclear terrorist strike would have such widespread community impact, local officials must be aware of the potential for such an attack. Effective planning, along with coordination among local, State, and Federal agencies for the response to a survivable nuclear radiation attack, is essential to a successful response.

BIOLOGICAL TERRORISM

In April and May of 1979, an anthrax epidemic broke out among residents in the city of Sverdlovsk in the former Soviet Union. Soviet officials claimed at the time that the outbreak stemmed from contaminated meat. The windborne spread of anthrax caused a 6-week epidemic that claimed approximately 66 lives. Some of the deaths occurred at victims' homes, in the streets, and in fields. Soviet officials later admitted that the incident resulted from leakage from a biological weapons facility.

Anthrax, along with several other biological agents, can be adapted for use as terrorist weapons. These agents pose very serious threats because they can be produced easily and inexpensively, and they can spread rapidly, potentially causing a devastating number of casualties.

COMMUNITY IMPACT

The deliberate release of a biological agent such as anthrax would have a highly debilitating and largely unpredictable impact within a community. The probable choice of a densely populated, highly visible target, such as a place of public assembly, public building, mass transit system, or an area with historical or symbolic significance, would imperil great numbers of people in and beyond the target area and overwhelm the support systems that serve them.

Because some of the symptoms of biological agent infection are common to many diseases, diagnosis and treatment of mass casualties are extremely difficult. (In the Soviet incident, medical personnel who transported victims often made an initial diagnosis of pneumonia.) The lag time from exposure to the exhibition of initial symptoms and signs, coupled with the potential for misdiagnosis, could enable widespread dispersion of victims, far beyond the initial target area and for an unpredictable period of time after the release, depending on the incubation period of the disease and the number of people initially infected. In some cases, treatment of victims after the exhibition of symptoms and signs and delays in diagnosis could prove fatal to great numbers of people. For example, almost all cases of inhalation anthrax in which treatment begins after the exhibition of symptoms and signs result in death, regardless of treatment.

A widespread outbreak of an infectious disease would threaten the ability of emergency and medical facilities to respond. Personnel within these facilities should be at risk of infection themselves, especially prior to a certain diagnosis of the disease. (For biological warfare agents, concern for person-to-person contamination is limited to two agents: smallpox and pneumonic plague.) The collection and disposal of contaminated material, including human remains, would present additional long-term problems.

The psychological effects of a biological agent release could have a severe impact. A panic response by the population, including potentially widespread psychosomatic reactions, would magnify the crisis by further overwhelming treatment facilities and possibly clogging transportation systems in the search for treatment or escape from a perceived target area. Also, the sense of obligation to provide immediate assistance could endanger untrained or unprotected personnel who would be compelled to deal with an unknown, highly transmissible disease. Trained healthcare personnel employing proper protective practices for airborne (e.g., TB) and bloodborne (e.g., HIV) diseases could expect to care for patients safety with negligible risk.

PREPAREDNESS THROUGH PLANNING

There is no reasonable means of protecting a city's population against the effects of a release of a biological agent. Vaccination of a population not specifically at risk against so many potentially harmful agents is impractical, as is continuous wear of personal protective equipment (PPE). Furthermore, no known means of immunization exists for several of the recognized agents. As was the case in the Soviet Union, the responsibility for first response to a biological release on a civilian population will be that of local officials. Local public health authorities and private health care providers must be aware and vigilant and communicate with each other where and when suspicious cases arise. Only by early diagnosis and communication of suspicion and developing a detailed plan to combat an attack of this nature will officials be able to respond effectively.

Essential to the planning process is an awareness of the agents that exist, their symptoms, incubation periods, limitations on laboratory diagnosis and mortality rates. The following listing of common biological agents includes these aspects of each agent.

However, as a local official, you should ensure that your city has several persons whom you can rely on for specific information about these and other biological agents.

AGENTS	SYMPTOMS	INCUBATION PERIODS	UNTREATED MORTALITY RATES
Bacterial Agents			
Anthrax (*B. anthracis*)	Fever, malaise, fatigue, cough and mild chest discomfort followed by severe respiratory distress with painful breathing, sweating, wheezing, and cyanosis	1–6 days	Skin: 5–20% Respiratory: 100%
Plague ✦ Bubonic ✦ Pneumonic	Malaise, high fever, and tender lymph nodes High fever, chills, headache, coughing up blood, and toxemia, progressing rapidly to painful breathing, wheezing, and cyanosis	2–10 days 2-3 days	50% 100%
Bacterial/Viral Agent			
Q-Fever (rickettsia)	Fever, cough, and chest pain	>10 days	Less than 1%
Viral Agents			
Smallpox	Malaise, fever, rigors, vomiting, headache, backache, and lesions	7–17 days	30%
Viral Hemorrhagic Fevers (Ebola, Marburg, Lassa, Rift Valley, Dengue, etc.)	Fever, bleeding, vomiting, and diarrhea	3–21 days	Up to 90%, depending on the virus
Venezuelan Equine Encephalitis (VEE)	Malaise, fever, rigors, headache, nausea, vomiting, cough, sore throat, and diarrhea	2–6 days	Less than 1%

PREPAREDNESS THROUGH PLANNING

AGENTS	SYMPTOMS	INCUBATION PERIODS	UNTREATED MORTALITY RATES
Toxins			
Staphylococcus Enterotoxin B (SEB) (Cytotoxin)	Fever, chills, headache, aches, and cough if inhaled; nausea, vomiting, and diarrhea if swallowed	3-12 hours	Less than 1%
Botulinum (Neurotoxin)	Weakness, dizziness, dry mouth and throat, blurred and double vision, descending paralysis, and respiratory failure	24 hours to several days	60%
Ricin	Weakness, fever, cough, and hypothermia	4-8 hours	High, with death occurring after 36–72 hours

The health and medical community has developed initial guidelines for prevention and/or treatment of these agents. Consult with local public health authorities and medical care providers for more information about prevention and treatment.

CHEMICAL TERRORISM

In June 1994, terrorists released the nerve agent sarin outside an apartment building in the city of Matsomoto, Japan. Then, on March 20, 1995, the same agent was released in the Tokyo subway system, causing more than 5,500 people to seek medical attention. Although no episodes involving chemical weapons of mass destruction have occurred in the United States to date, the threat was made to release sarin at Disneyland on Easter Sunday 1996. With the processes for synthesis of chemical warfare agents available as readily as on the Internet, the potential for a chemical attack in this country cannot be discounted.

COMMUNITY IMPACT

The deliberate release of a chemical warfare agent, such as sarin, would have a highly debilitating and largely unpredictable impact within a community. The probable choice of a densely populated, highly visible target, such as a place of public assembly, public building, mass transit system, or a location with historical or symbolic significance, would imperil large numbers of people in the target area and incapacitate the support and infrastructure systems that serve them. The victims in the target area could suffer the effects of certain chemical attacks within seconds, requiring immediate evacuation and treatment. Conversely, some agents have a more delayed effect, causing casualties hours or days after the initial impact of an attack would seem to have subsided, thus widely enlarging the area of impact.

The evacuation and treatment of the known victims of a chemical release, with the inherent risk of contamination, would tax the community's emergency transport system and medical facilities. Further, positive identification of the agent is a difficult task because, as in the case of sarin, some liquid agents can evaporate, leaving little, if any, trace. Local health officials may be required to make a decision to provide immediate treatment for victims based on information at hand, rather than wait for positive identification of the agent. The collection and disposal of contaminated material, including human remains, would present additional problems.

Introduction of a chemical agent into a vital segment of a community's infrastructure would not only incapacitate that segment, but also could be a means for further dissemination of the agent. For example, in the Tokyo incident, liquid sarin was placed on the floor of subway cars. When an agent is dispersed inside in this manner, its vapor will remain until it is ventilated away. If, however, an agent is placed inside of a ventilation system, the system itself could disseminate the agent, contaminating the entire structure that it serves. An agent introduced into the ventilation system of a large medical facility would incapacitate the means of treatment and endanger both those who seek aid and those who provide it. A secondary attack of this type could imperil those who might seek shelter (e.g., in a public building) or a means of escape (e.g., in a public transportation system).

The psychological effects of a chemical weapons attack could have a severe impact on the community well. The implications of such an attack could cause panic among a wider population than actually is affected, with greater numbers of people seeking treatment than have been physically harmed. For instance, although 5,500 people sought medical attention after the sarin attack in Tokyo, only 1,000 were actual casualties, and most had mild effects. Hysterical citizens could clog medical facilities, hampering the treatment of the victims suffering physical effects of the agent and overwhelming crisis management capabilities.

COMMUNITY IMPACT

The unpredictability of a chemical attack with regard to the choice of target, the ability to identify the agent, the danger of widespread contamination, the damage to infrastructure, and the reaction of victims and responders requires a predictable and effective emergency response.

PREPAREDNESS THROUGH PLANNING

Because there is no known means of protection of the civilian population against the effects of chemical agents—an impracticality for populations not specifically at risk—preparedness for a potential release of chemical agents is essential. [**Note**: First responders can protect themselves with the use of personal protective equipment (suits, masks, etc.).] Although, historically, chemical warfare agents have been considered a military responsibility, the first response to their release on a civilian population in an American city will be the responsibility of local officials, as it was in Tokyo. Only by developing a detailed plan to combat an attack of this nature will officials be able to respond effectively.

Essential to the planning process is an awareness of the agents that exist, their symptoms, and the hazards that they would present to the community. The following list of common chemical agents includes these aspects of each agent.

However, as a local official, you should ensure that your city has several persons whom you can rely on for specific information about these and other chemical agents.

PREPAREDNESS THROUGH PLANNING

AGENTS	PERSISTENCY (BY AGENT)	SYMPTOMS (ALL AGENTS)	HAZARDS (ALL AGENTS)
Nerve Agents			
◆ GA (Tabun) ◆ GB (Sarin) ◆ GD (Soman)	◆ Minutes to hours ◆ Minutes to hours ◆ Hours	◆ Pinpointing of pupils ◆ Dimness of vision ◆ Runny nose/salivation ◆ Tightness of chest ◆ Difficulty breathing ◆ Twitching and/or paralysis ◆ Tachycardia ◆ Vomiting ◆ Loss of consciousness ◆ Convulsions ◆ Incontinence ◆ Death	◆ Respiratory dose is effective within seconds to minutes. Skin dose is effective within minutes to hours. ◆ Extremely toxic lethal agents
◆ VX	◆ Hours to days	◆ Sweating ◆ Nausea, vomiting, and diarrhea. ◆ Loss of consciousness ◆ Convulsions ◆ Incontinence ◆ Death	◆ Predominantly a liquid hazard. Effective 10 minutes to 18 hours after exposure.
Blister Agents			
◆ H (Mustard) ◆ HD (Mustard) ◆ HN (Mustard)	◆ Hours to days ◆ Hours to days ◆ Hours to days	◆ Reddening of skin ◆ Blisters ◆ Eye pain and reddening ◆ Eye damage ◆ Coughing ◆ Airway irritation and damage	◆ Damage begins within minutes. ◆ Eye effects may appear in a few hours, respiratory effects and blisters in 2-24 hours. ◆ Lethal in large doses
◆ L (Lewisite)	◆ Hours to days	◆ Immediate pain or skin irritation ◆ Other symptoms similar to the H agents	◆ Immediate pain. Other symptoms in about 12 hours. ◆ Lethal in large doses ◆ Immediate pain and damage to eyes, skin, and airways.
◆ CX (Phosgene Oxime)	◆ Hours to days	◆ Immediate burning ◆ Eye and airway irritation and damage	◆ Immediate pain and damage to eyes, skin, and airways. ◆ Lethal in large doses
Blood Agents			
◆ AC (Hydrogen Cyanide) ◆ CK (Cyanogen Chloride)	◆ Minutes to hours ◆ Minutes to hours	◆ Cherry red skin or lips (Caucasians only) ◆ Blue lips (African American or dark-skinned people) ◆ Rapid breathing ◆ Dizziness ◆ Nausea, vomiting ◆ Headache ◆ Frothing ◆ Convulsions ◆ Death	◆ Can cause death within 6-8 minutes.
Choking Agents			
◆ CG (Phosgene)	◆ Minutes to hours	◆ Eye and airway irritation ◆ Dizziness ◆ Tightness of chest ◆ Choking ◆ Vomiting ◆ Delayed pulmonary edema	◆ Effects are delayed several hours. ◆ In very high doses can result in death after several days.
◆ Chlorine	◆ Minutes to hours	◆ Coughing	◆ Effects begin seconds after exposure.